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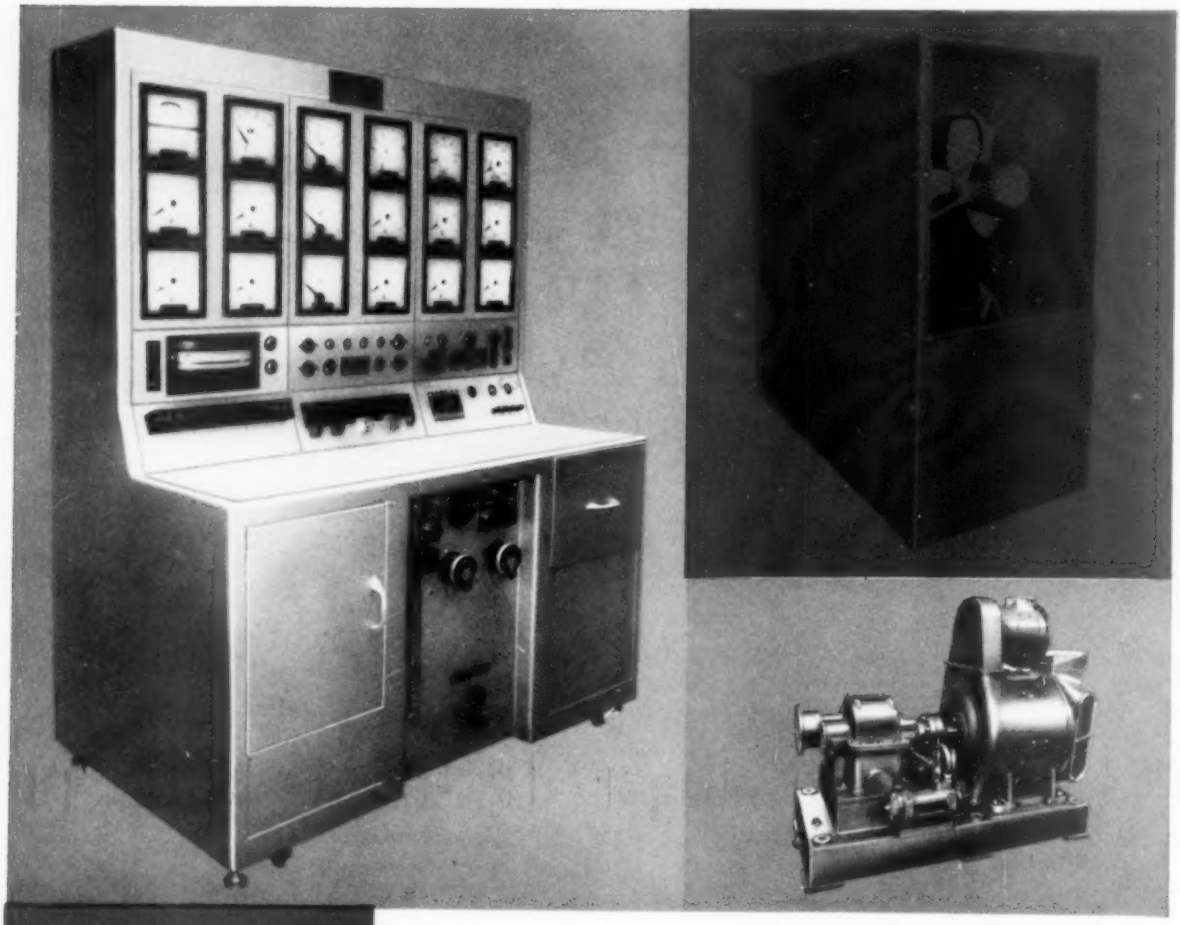

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Fifth engine tests Boeing 727 design feature

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The prototype is shown above equipped with a fifth engine, conducting exhaustive tests of the efficiency and performance of side-mounted engines, a feature of the 727. In addition, the 707 prototype is testing new high-lift wing flaps, aircraft systems and other design features that will make the 727 the most advanced jetliner of its class.

Already, one hundred and seventeen 727s have been ordered by American Airlines, Eastern Air Lines, Lufthansa German Airlines and United Air Lines. Deliveries begin in 1963. The 727 will operate from 5,000-foot runways with full payload, serving routes from 150 to 1700 miles. It offers airlines many advantages, including components and systems that have demonstrated outstanding performance and reliability in over 300,000,000 miles of Boeing jetliner operations.

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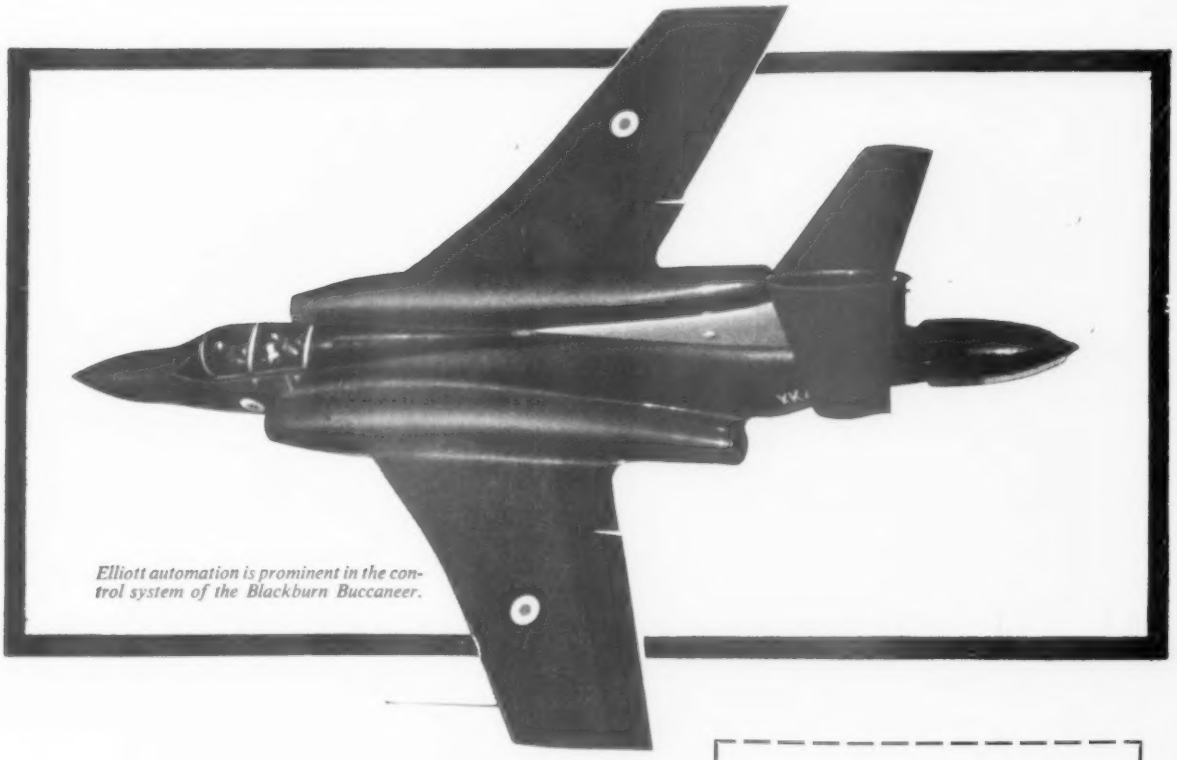

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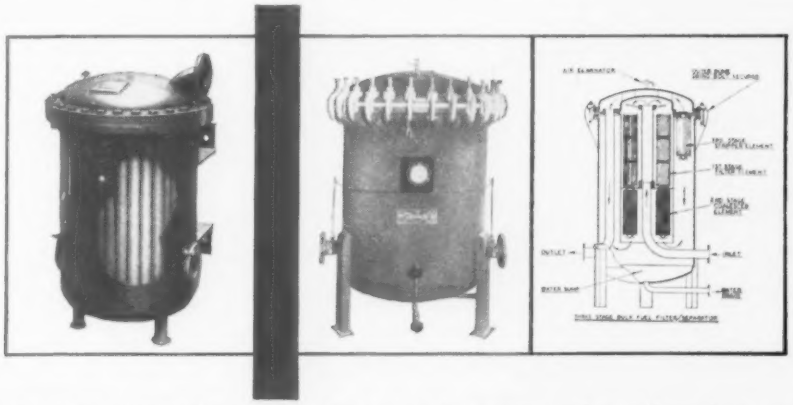
Other Stream-Line equipment (not illustrated) used for the filtration of aviation fuel include a monitor which continuously samples the flow of fuel for the presence of water and the high output MC filter which gives an acceptable filtration efficiency at a much higher flow rate than the K type.



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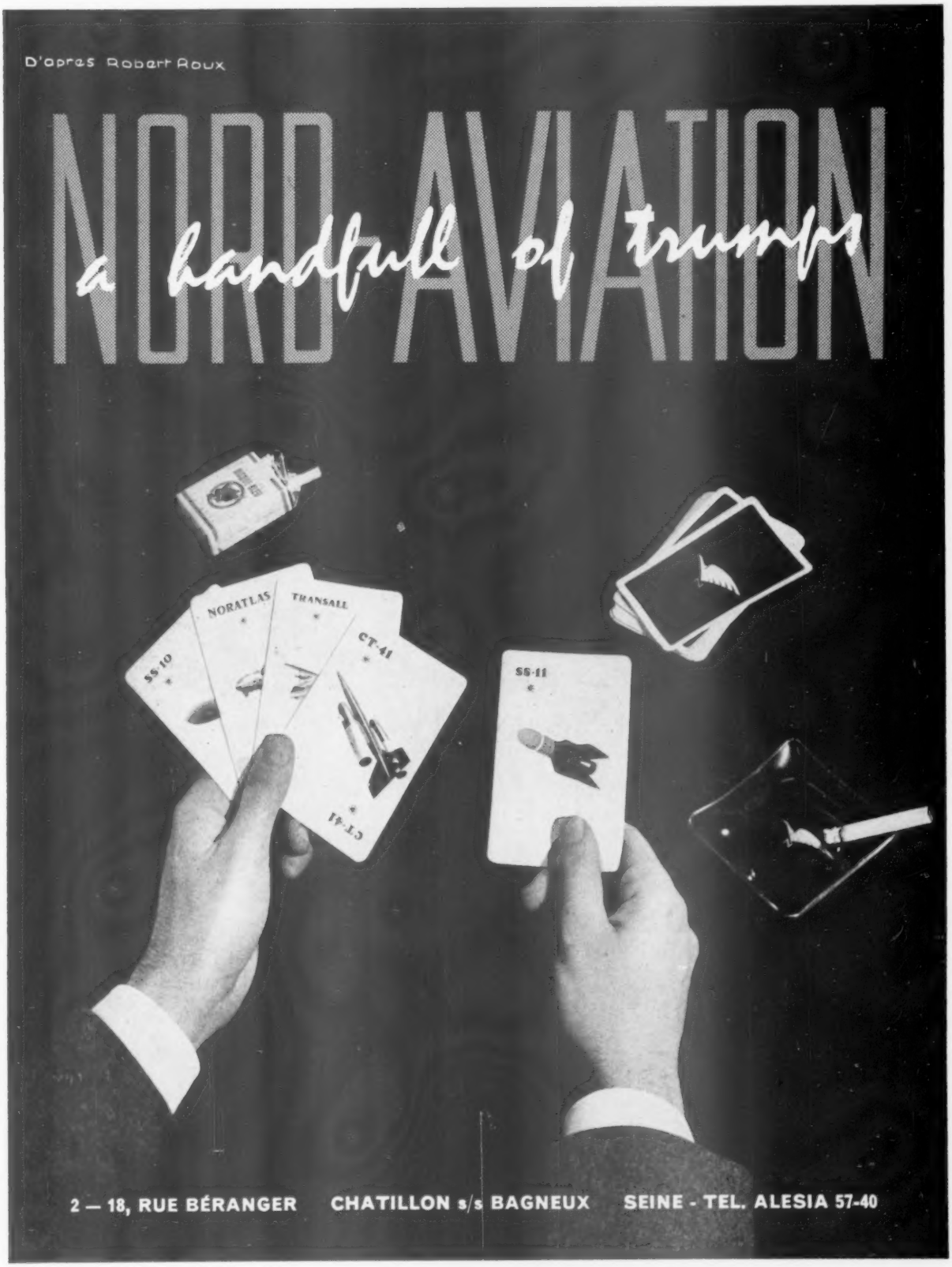
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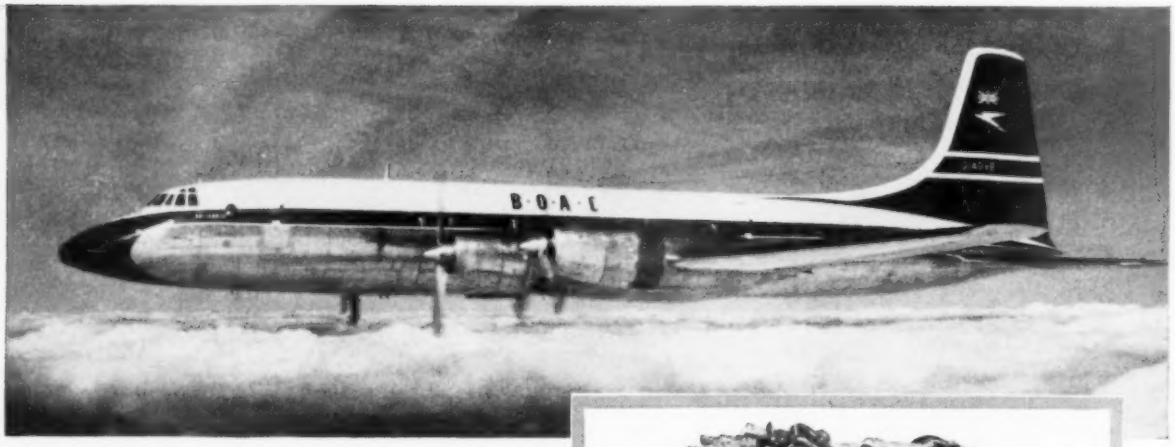

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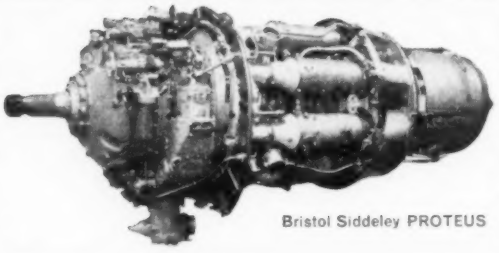
The development of the all-electric throttle control system for the Bristol Britannia was an ULTRA first. The operational performance, including outstanding reliability during some 2,000,000 flying hours, has fully justified the choice of the system. We are at present developing similar systems for Short Bros. and Harland (for the Belfast) and for the Bristol Siddeley Engine Company (for the Olympus to be used on the British Aircraft Corporation TSR2).



Bristol Siddeley PROTEUS

SPEED & TEMPERATURE CONTROL

Equipment for automatic control of engine speed and temperature by fuel trimming—an integral part of the complete throttle system—is supplied separately, and is extensively used by leading engine manufacturers. Rolls-Royce, for example, have specified Ultra Speed and Temperature Control equipment for the Conway RCo. 42 engine, to be fitted in the VC10, and also Temperature Control equipment for the Avon RA29 engine used in the Caravelle.
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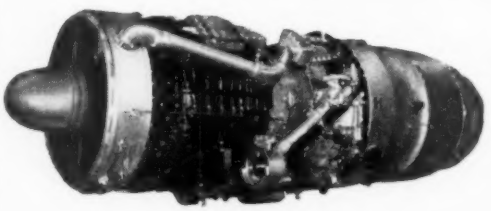
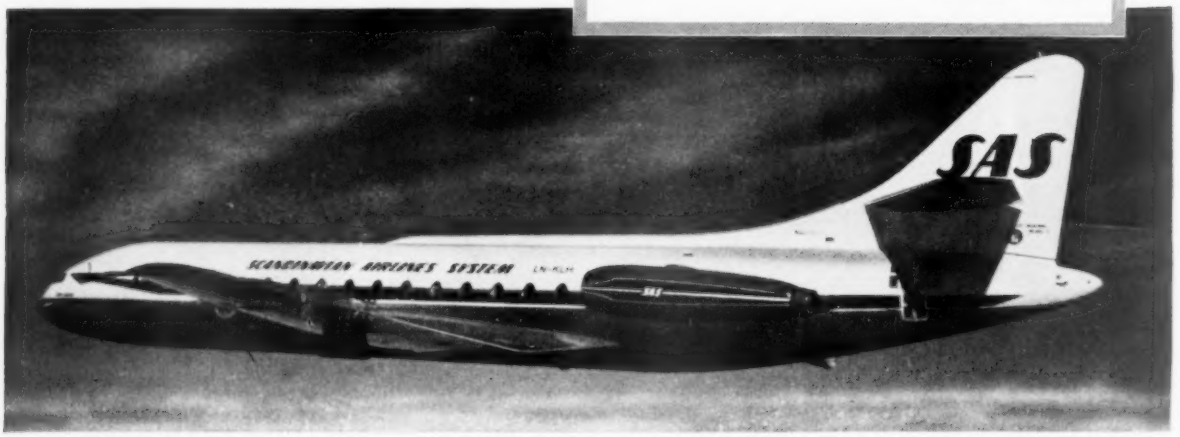


Rolls-Royce AVON



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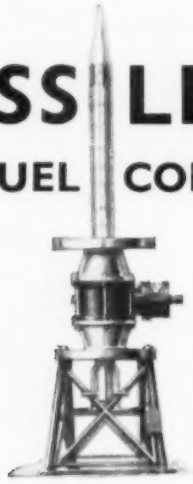
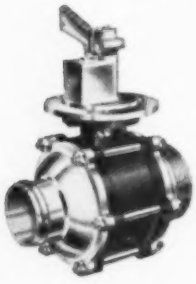


Development is continuous in design and production of valves for the control of airborne and ground duty fluids.

SAUNDERS VALVES



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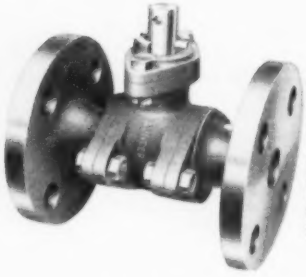
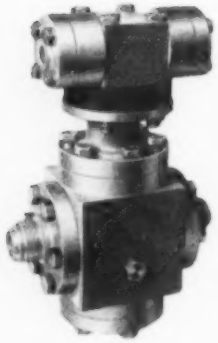
Spherical Plug 'airborne' practice is adopted for body and end connections of this unit designed expressly for handling Hydrogen Peroxide. Multi-way, Non-Return and Relief Valves are also available. Sizes ¼" to 3"



H.T.P. INDUSTRIAL VALVES

Spherical Plug and Central Housing are of similar construction to the Airborne model. End connections can be flanged, screwed or clamp type to suit the installation. Sizes 1" to 6"



L.O.X. VALVES

The photograph alongside shows a valve of basic S.P. design with compressed air power unit for handling L.O.X. Specifications can be varied to include components compatible with the fluid handled and in addition to the unit illustrated there are valves in production for handling Freon, Nitrogen, and Carbon Dioxide (CO_2). Sizes ½" to 3" with end connection to suit the duty.

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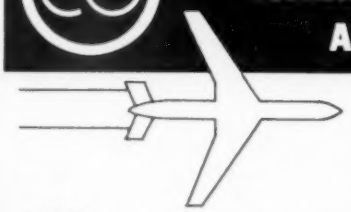

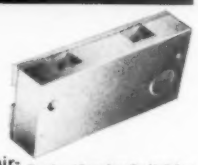

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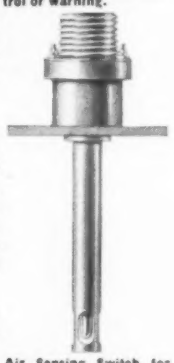
Equipment such as this is fitted to the Trident, VC10, Vanguard, Argosy, Avro 748, Fairey Gannet, etc.



Air Sensing Switch for duct temperature sensing.

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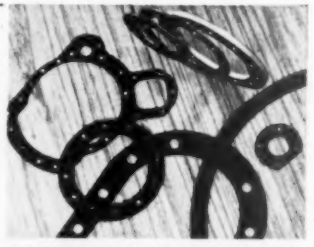

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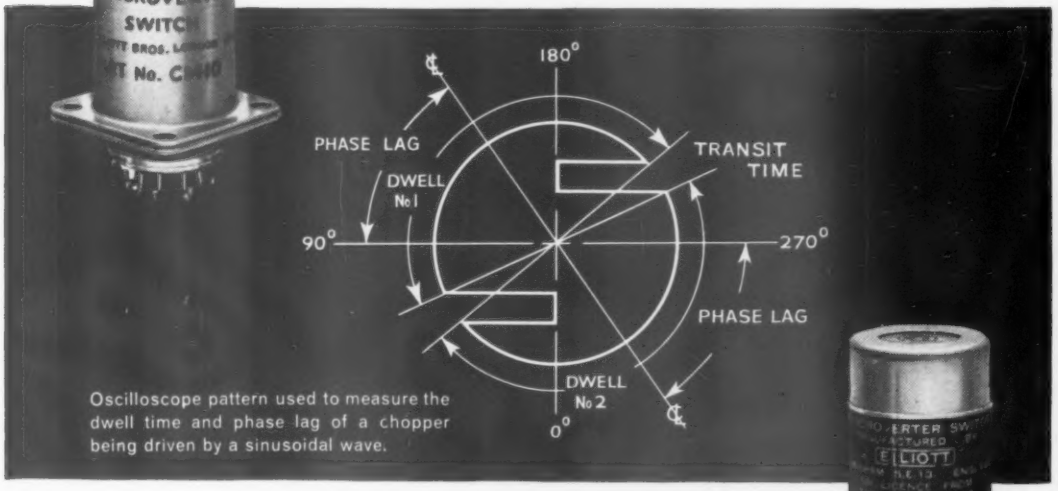

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Beyond our skies

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Nebulae

Vast clouds of cosmic dust, some bright and shining, others absolutely dark, are found in the heavens, keeping station with the "fixed" stars. Bright nebulae are excited to luminosity by the proximity of bright and very hot stars, although some shine by reflected starlight. Others are visible only as dark patches against the Milky Way. Examples of these are the "great rift" in Cygnus and the "coal sack" in the Southern Cross. It is believed that nebulae may well be the raw material of new stars and new worlds. There are two main classes of nebulae: the galactic, which are gaseous and diffuse, and spiral nebulae. The gaseous nebulae in turn are of two types—the irregular, near the Milky Way, and the planetary, at some distance from it. Both types appear in association with stars of higher temperature than the Sun. Spiral nebulae are much more compact than diffuse nebulae, are oval or round in shape and generally much brighter. The largest, and probably the nearest, is the Great Nebula in Andromeda, covering two square degrees. It has a nucleus very much brighter than the rim, with two spiral arms in the manner of a catherine wheel.

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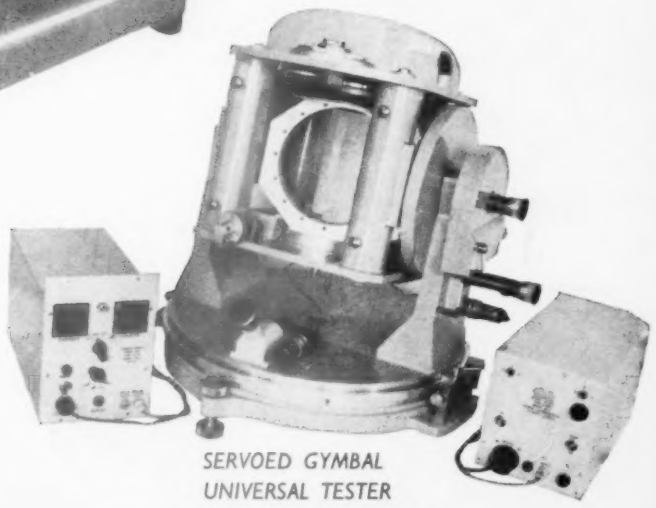

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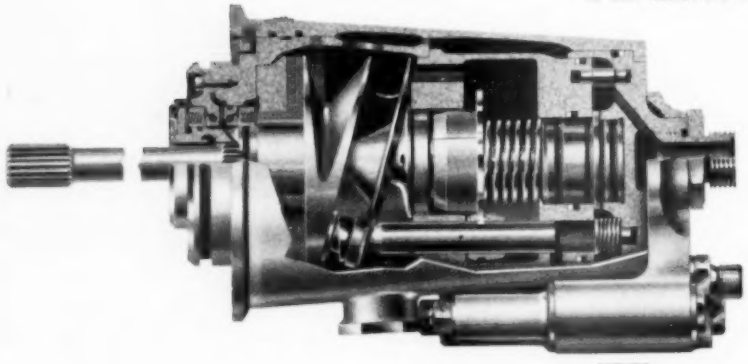

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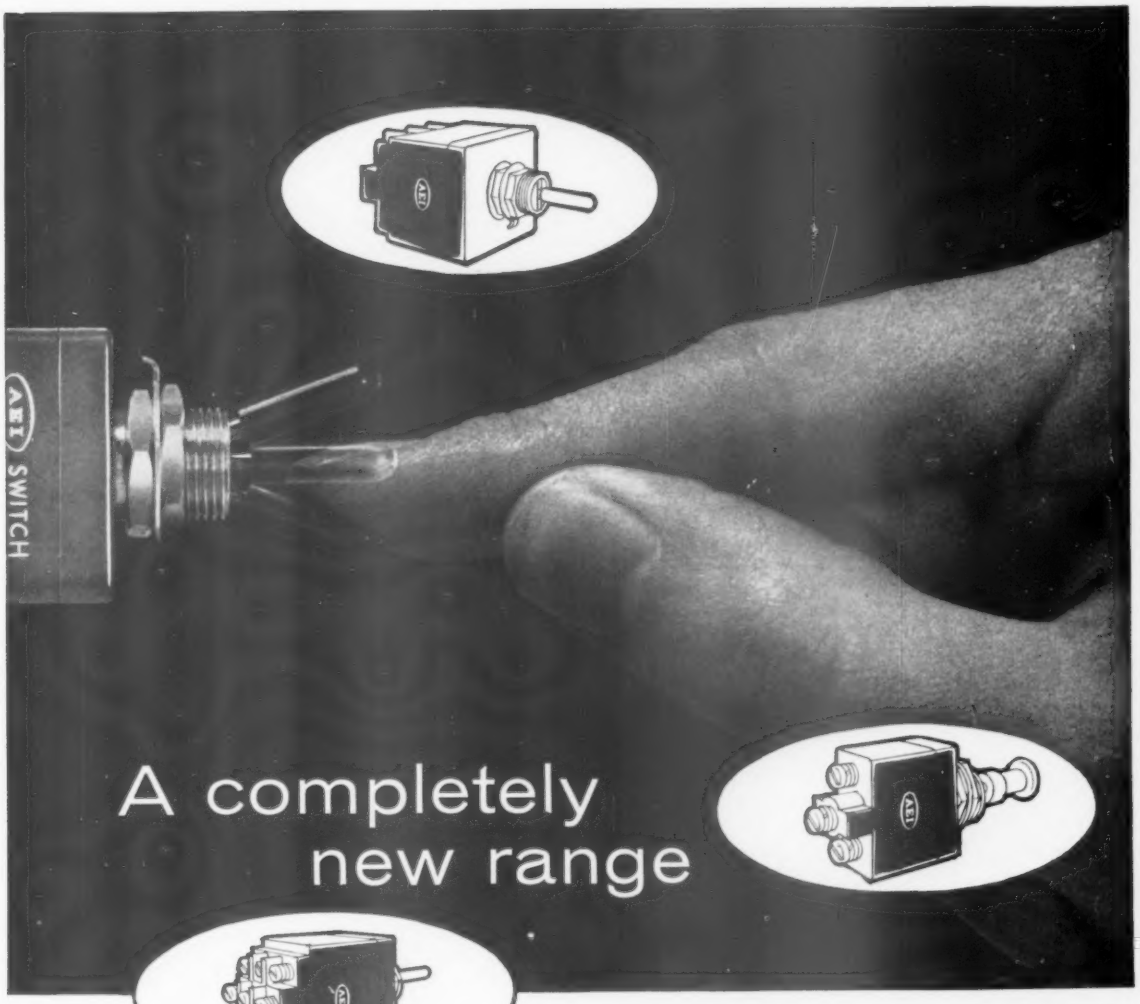

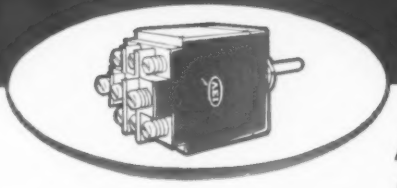

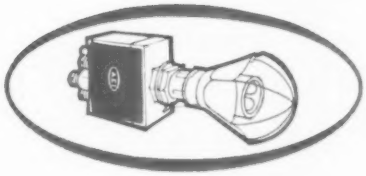

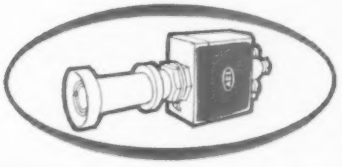

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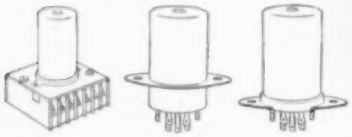

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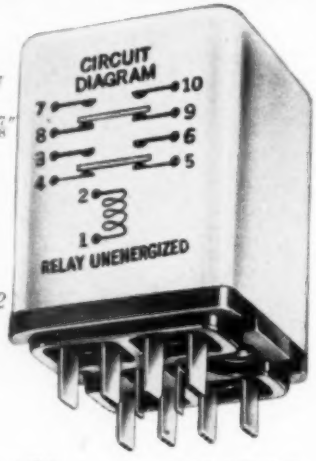

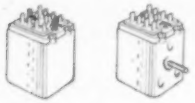

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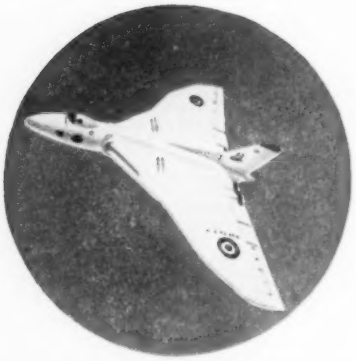

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THE AEROPLANE and ASTRONAUTICS

VOLUME 101 NUMBER 2608 OCTOBER 12, 1961

Co-ordinating Developments

Recent news that proposals regarding the selection of certain sites in central London as possible heliports have been turned down, has directed attention towards a pressing problem. On the assumption that city-centre scheduled passenger services with helicopters are worth while—and if operation from really confined spaces in closely built-up areas is contemplated, it is difficult to see how the STOL aeroplane can hope to compete with the VTOL helicopter—the need for suitable alighting sites is imperative.

We now seem to have all the ingredients for a Gilbertian situation in which commercial helicopters for scheduled services cannot be ordered until appropriate operating sites are available and these in turn are not likely to be built until there is some positive sign that the vehicles will materialize.

However that particular problem may come to be resolved, it is true enough that even if the vehicles did exist they could not be used for city-centre operation until the heliports were ready for them. It has also been stated in a recent lecture in London that until a suitable integrated flight control system is—to use the words of the lecturer—devised, developed and certificated, scheduled civil helicopter services cannot be contemplated.

Any form of commercial transport operation is, in many respects, akin to the weapons system concept that plays such an important part in Service aviation. A number of integrated components go together to make the whole—and the individual pieces in themselves are useless. This is particularly true of rotary-wing transport; heliports are just as much a part of the essential equipment as navigation aids and autopilots. Thus, if the final object is to be achieved some parallelity of development of these components is of paramount importance.

In this particular context, however, parallel lines of progress may not be quite good enough; it is a well-known property of such lines that they never meet. What is needed is a co-ordinated programme designed to bring the lines together at a point not too far distant. And to see that this is accomplished there should be, as we have so often said, a director of rotorcraft research and development at the Ministry of Aviation.

Astronautics on a Global Scale

Exploration of space began four years ago. Since Oct. 4, 1957, when the first artificial satellite of the Earth was put into orbit, man has put no fewer than 65 artificial moons into orbit round the Earth and four into orbit around the Sun. According to Dr. Hugh Dryden, the total weight of these man-made moons and planets is more than 75 tons. He was speaking in Washington on the occasion of the opening of the International Astronautical Federation—a first report of which appears in this issue, which is devoted to a special review of missiles and spacecraft. What time the Americans are preparing to launch at Cape Canaveral the first Saturn C-1 booster, rumours persist of new Soviet preparations for a space-launching to keep a man in orbit for three or more days.

Nevertheless, the questing spirit of man is unlikely to be stilled by any "technical" setback. As Dr. Dryden states, it is vital that astronautics develops on a global scale. This is not only important because of the ever-mounting cost of space exploration, but because of the obvious need to keep the spaces beyond the Earth untainted from national rivalry. This has been a concern of the I.A.F. from the beginning.

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Matters of Moment

Beagle Production Plans

FINAL approval is being sought by British Executive and General Aviation, Ltd.—the Beagle Group—for the expansion of its premises at Shoreham, which would then become the main production and assembly centre of its companies. A Board of Trade industrial development certificate has been granted for a replacement building plus an extension totalling 202,000 sq. ft., for the manufacture of aircraft and components and accommodation for drawing, design and administrative offices. Agreement for this development has been reached with the local planning authorities, but the final go-ahead is still awaited from the county and ministerial organizations.

Further expansion at Shoreham was initially refused by the local councils, until the precise nature of Beagle requirements was pointed out by managing director Peter Masefield. The proposed building, which is to be erected in stages over six years, is to replace some 45,000 sq. ft. of temporary hutments along the south-east side of Shoreham, and to provide properly planned floor space for the assembly of light aircraft and sub-contracted components. New buildings would also be erected to the west of the present airport administrative centre and hangars, and would be landscaped to present as attractive an aspect as possible.

As the new building is planned primarily as an assembly hall, receiving many components from sub-contractors, an employment of only about 800 workers at the airport is foreseen. A substantial proportion of this total is already in the employ of Beagle-Miles Aircraft, Ltd., at the airport. Expansion would be limited to around the proposed figure, and would mean employing only about 350 additional semi-skilled personnel.

At a recent conference on the proposed expansion, Peter Masefield pointed out that Shoreham, as one of the oldest airfields in the country, had an almost continuous record of aircraft production since 1910. It offered a number of unique advantages as a centre for the design and assembly of the lighter types of aircraft, being close to London, with good surface communications; convenient to the Continent and clear of control zones; having a good weather record; and of the right size for the sort of flying envisaged. It was an attractive centre for British light aviation, and the existing club flying would be encouraged.

Although a large proportion of the proposed new range of Beagle aircraft will be sub-contracted to such concerns as Boulton Paul at Wolverhampton, Scottish Aviation at Prestwick, Vickers-Armstrongs at Swindon and Pressed Steel at Cowley, final assembly and flight testing would be at Shoreham. Refusal of the scheme, said Mr. Masefield, would be a serious matter for the Beagle companies, and, in his view, to the country, since at present imports of American business aircraft are costing our economy more than £1 million a year.

The extra production capacity would be needed by Beagle before the end of 1963, with a planned output amounting to about £2 million a year. About one-quarter of this figure was already realized from Shoreham, where Beagle-Miles Aircraft was manufacturing engine cowlings for the Rolls-Royce turbojets of the Boeing 707 and the Caravelle. Most of these are for export, and Beagle estimates that about 70 per cent. of its future output will be exported.

So far as progress with the Beagle range is concerned, a major consolidation programme is currently in hand. The prototype B.206X executive twin has not been flying since Farnborough, because of its extensive installation programme of test instrumentation. It was due to begin its major test schedule last Monday. The first production Beagle-Auster Airedales are due within a month or so, after completion of an intensive campaign of refinement, including particular attention to reducing the noise level.

Comparative performance tests are also being undertaken between the Lycoming- and Continental-engined prototypes. The Terrier programme is also continuing with the object of producing handling qualities as near as possible to those of the Chipmunk, with the help of geared tabs, and of improving flap effectiveness by reducing flow breakaway at large angles of deflection.

E.S.L.O. to Meet

AFTER months of delay and indecision, the long-heralded further meeting between the countries concerned in setting up the European Space Launcher Organization is expected to be held later this month. The Anglo-French invitation has been extended to those countries which were represented at the Strasbourg Conference in January.

The aim of the further meeting is to draw up a Convention under which E.S.L.O. would operate. So far Germany, Belgium, Denmark, Spain and the Netherlands have agreed to attend. Austria, Switzerland and Norway have declined and replies are still awaited from Italy and Sweden. The original deadline for replies to be received was the end of March.

As we observed last month, the decision of Norway and other countries not to take part in the project will necessitate some reapportioning of the proposed national budgets. At Strasbourg, these were as follows:—

United Kingdom	£23,333,000	Belgium	£1,993,000
France	14,399,000	Netherlands ..	1,850,000
West Germany ..	13,244,000	Switzerland ..	1,582,000
Italy	6,846,000	Denmark ..	957,000
Spain	2,063,000	Austria	927,000
Sweden	2,033,000	Norway	773,000

The European heavy satellite launcher, as presently conceived, will consist of the de Havilland Blue Streak, with French and German rockets as upper staging. The Strasbourg proposals allowed for a total of 10 development launchings at Woomera by the end of 1965.

This was the programme: First firing of a Blue Streak by midsummer 1962, with a second in December embodying dummy second and third stages. Two "back-up" vehicles were allowed for in 1963, with one launching of a Blue Streak embodying a dummy second stage and a live third stage in October. Two further launchings of the latter arrangement would occur in 1964. Finally, in 1965, would come the firing of three complete vehicles capable of placing satellites in orbit.

FIRST OFF.—Westland-Saro Scout helicopters for the Army are now in production at the company's Fairey Division at Hayes. The first of these craft came off the production line recently and is here seen being prepared for road transport to White Waltham, where production flight tests are to be done.

FOR GREECE.—The first Fiat G.91R4 for the Royal Hellenic Air Force was recently handed over. Powered by Bristol Siddeley Orpheus turbojets, Fiat G.91s are in service with the West German and Italian air forces and on order for Turkey.

Discussing North Atlantic Navigation

REPORTS are coming in on the progress of the ICAO North Atlantic Regional Air Navigation Meeting which began in Paris on Sept. 14 and goes on until Oct. 12. There is always the chance that the direction of the discussions will take a new turn towards the end of the conference, but indications are that a fair measure of agreement will be reached in tidying up the navigational services—but not in revolutionizing them.

In some ways this is a pity, since it is rare that an ICAO regional meeting has produced anyone bold enough to put up revolutionary ideas—as the U.K. and Ireland have done in this case in proposing a "roll-up" airways system for North Atlantic upper airways traffic. The dominant idea was to reduce the number of crossing tracks of same-way and opposite-way traffic by channelling all eastbound flights into a comparatively narrow band and westbound into a similar band. With the usual pressure distribution this would mean a southerly rhumb-line or Great Circle for the eastbound, and a northerly composite or Great Circle for the westbound: in an abnormal pressure distribution the flow would be reversed. The selection of the track system in use at any one time would be determined by some suitable arrangement between the airlines and the Oceanic Air Traffic Control. By this means the Gander and "Shanwick" controls would have much closer knowledge of possible traffic conflicts and would be happier at reducing the present 30-min. longitudinal spacing, which is, of course, enormously extravagant in airspace.

But, as throughout all aviation, one never gets something for nothing and it is understandable that an airline operating from Rome to New York would not want to route up to Shannon merely to join the westbound flow. So, on these and other grounds, the proposal met heavy weather and was eventually turned down. The Canadian compromise solution—a variable datum line between east and west flows, with no attempt at actual channelling into an airways system—was accepted.

The 30-min. time separation is, however, to be reduced to 20 min. for upper level flights and for aircraft which are known to have approximately the same cruising speed and to have left over the same fix. The decision will increase the amount of this traffic by 50%.

In the field of navigational services a considerable improvement in Volmet W/T broadcasts may be expected by transferring the Paris service to Shannon (giving Shannon double time); reducing some of the frills in message content (e.g., QNH); standardizing the message format as between Gander and Shannon; and suggesting a study of Volmet transfer from New York to Gander. Air/Ground HF communications also came in for some refurbishing, the principal move being to off-load some of the traffic from the B and C families to family A, and occasionally, in conditions of extreme congestion, to D; at the same time the common use of the single 13 Mc/s order frequency between families B and C will be discontinued, B taking on 13284.5 and C taking on 13354.5 while the more lightly loaded A and D will share 13324.5 Kc/s.

But, for all that, one has the impression that the air/ground communication service over the Atlantic is the weakest part of the traffic organization: aircraft today are often out of touch with ground stations for over an hour and goodness knows what it would be like if pilots stuck to the official priorities for Met. information (request/reply, directed messages, Volmet) and what it will be like in 1964-5, when HF propagation conditions are forecast at their lowest (390 miles skip distance at Shannon and 625 miles at Gander). Perhaps the special emergency meeting which will be called will remember that, in 1961, when a firm recommendation could have been made to put the Met. traffic on to radio-teletype, the 4th NAT shuffled out of its responsibilities and put the matter over to 7th COM, which, meeting in 1962—and with other troubles besides the North Atlantic—will scarcely be in a position to give the subject the full attention it deserves.

I.A.F. Congress in Washington

CROWDED SESSIONS—both technical and business—attended the 12th Congress of the International Astronautical Federation which was held in Washington from Oct. 2-7. Representatives of 27 nations were present. In addition to the various technical symposia there were panel discussions; the 4th Colloquium on the Law of Outer Space (held under the auspices of the Institute of Space Law); and the first meetings of the International Academy of Astronautics.

Technical sessions included the presentation of papers on astrodynamics, space propulsion, guidance, energy conversion, radio and radar exploration of the Solar System, biochemical aspects, communications, vehicles, structures, systems and instrumentation. British contributions included: "An Examination of the Characteristics of Propulsion Systems for Inter-orbital Transfer," by P. A. E. Stewart (Hawker Siddeley Aviation); "Blue Streak as First Stage of a Satellite Launcher," by G. K. C. Pardoe (de Havilland Aircraft); "Propulsion of the Final Stage of a Satellite Launcher Using Liquid Hydrogen as Fuel," by A. W. J. Mottram (Bristol Siddeley Engines); and "Review of Recent Studies of Crack Propagation," by A. J. Murphy (College of Aeronautics, Cranfield).

The address by Dr. Hugh L. Dryden, who opened the technical sessions on Oct. 2, is summarized on page 501.

Electricity in Aircraft Control

A CONFERENCE on "The Importance of Electricity in the Control of Aircraft" is to be held in London on Feb. 26-28, 1962. It has been organized by the joint committee of the Institution of Electrical Engineers and the R.Ae.S., which was formed last year with the object of promoting joint meetings and the discussion of matters of interest common to both bodies.

The organizers anticipate that about 30-40 papers will be presented and that the subject matter will be sufficiently wide to interest aircraft and equipment designers and specialists in all fields of aircraft electrical and electronic development. The emphasis will be on system design and methods of achieving the required reliability for these systems—this being one of the major problems facing the aircraft electrical industry.

The subjects to be discussed will include the degree of reliability required of systems, and the principles upon which this reliability might be achieved, especially in relation to future aircraft; developments in automatic flight control; developments in airborne navigation systems; developments in engine and fuel control; electrical systems in current aircraft; possible developments and techniques in electrical supply systems; the temperature problem associated with supersonic flight and its relationship to the future development of electrical and electronic equipment; and the application of new techniques to meet the needs of future aircraft.

"The Strategic Air Offensive Against Germany, 1939-1945"*

Air Marshal Sir Robert Saundby, K.C.B., K.B.E., M.C., D.F.C., A.F.C., F.R.E.S., R.A.F. (Rtd.), D.L., who reviews here the official history, served with Bomber Command from November, 1940, until the end of the war, as Senior Air Staff Officer and Deputy Commander-in-Chief. His book "Air Bombardment: the Story of its Development" which gives his views on the strategic air offensive, will be published by Chatto and Windus on October 19.

Introduction

THE kind of warfare which Bomber Command embarked upon in May, 1940, was substantially new, and the doctrines of the strategic air offensive were of necessity based on the experiences of the First World War. Their validity could not be proved until they were tested in actual warfare, and the subject was therefore highly controversial.

The authors of this history have had to go back to 1914 in order to make their narrative intelligible, and it is so complex that they decided to keep separate the three main aspects of the offensive—its strategy, its operations, and an appreciation of its results. The history is divided into an introduction and four main chronological parts, each consisting of three chapters dealing respectively with strategy, operations and results. There is a fourth volume of annexes and appendices.

The history begins with a lengthy appreciation of the nature of an air offensive. Air forces have a far wider choice of aim than either of the older Services and therefore the classical doctrine—that the aim in war must always be the destruction of the enemy's armed forces—need not apply to air operations. Aircraft cannot only destroy tanks, guns, or ships, but also the factories and yards where such weapons are built.

These possibilities raised moral issues. Even if the attack on targets such as oil plants, power stations, factories, shipyards, and railway centres was permissible, with an incidental risk to war workers and their homes, it was argued that it was immoral deliberately to attack civilian life and property. But, as the authors point out, a comparison between attacks upon specific factories and attacks upon industrial towns shows that this was often a distinction which disappeared in practice.

Preparation

Although it had been decided in 1925 to create a bomber force, progress was very slow. It is impossible to mention all the influences that hampered its development, but among them may be noted shortage of money, the League of Nations disarmament conference, the absence of any visible threat to Britain from the air, the Cabinet ruling that no major war was to be expected for ten years, and doubts about the morality of a strategic bombing offensive.

At the time of the Munich crisis in 1938 our bomber force was so weak that we abandoned, for the time being, any hope of being able to fight the air battle in the skies over Germany. We had to face an opening defensive phase with the crucial battle fought in our own air space. Priorities in almost everything had to be allocated to the requirements of air defence. The 8-gun fighter, radar for the plotting and interception of enemy bombers, fighter airfields, and the training of fighter pilots, all had to take precedence over the needs of the bomber force.

Thus it came about that when the war began Bomber Command was, in the words of the official history, "in no condition to engage in an all-out battle with Germany."

Endeavour

Severe casualties incurred during daylight attacks on German warships, in the late autumn of 1940, brought about a decision to concentrate on night bombing. But the difficulties of night navigation and bombing had not been fully appreciated until the long-range bombers became available. Little progress could be made in resolving them, because by that time scientific effort was preoccupied with the problems of air defence.

When Germany attacked in the west in May, 1940, Bomber Command attempted to check the enemy advance by attacks on railway centres, supply depots, and oil targets. "*Thus,*" say the authors, "*began the Bomber Command strategic air offensive against Germany. For many years it was the sole means at Britain's disposal for attacking the heart of the enemy.*" This great offensive "*never ceased until almost exactly five years later, Germany, with many of her cities in ruins, her communications cut, her oil supplies drained dry and her industry reduced to chaos, capitulated to the invading armies of the Grand Alliance. It was probably the most continuous and gruelling operation of war ever carried out.*"

At the outset the aim was the destruction of the German oil industry, involving the attack of many small targets. Before long photographic evidence showed that the bomber crews were unable to find their targets, except in especially favourable circumstances. This encouraged a policy of attacking industrial areas, rather than precise targets.

Thus matters stood when Air Marshal A. T. Harris became Commander-in-Chief in February, 1942. The strategic air offensive had accomplished but little by this date but, as the authors remark:

> "If less effort had been put into the offensive, Bomber Command would have been even further from discovering how successful attacks could be made on German industry and transport and the final victory certainly postponed, if not jeopardized altogether."

For the remainder of 1942 the Command was building up its strength and trying out new techniques of bombing, including a far higher degree of concentration and the creation of a Pathfinder Force. The 1,000-bomber raids had persuaded the Government to give, at long last, adequate priority to Bomber Command's urgent need for radar aids. At the end of the year two most valuable radar devices, OBOE and H2S, came into service. By the spring of 1943 the Command had been largely re-equipped with four-engined Lancasters and Halifaxes.

After three gruelling years Bomber Command had learned many lessons, and possessed at last the aircraft and equipment needed to carry out its task. This had been defined by the Combined Chiefs of Staff at Casablanca in January, 1943, in the following words:—

"*Your primary aim will be the progressive destruction of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their armed resistance is fatally weakened.*"

Victory

In March, 1943, Bomber Command began a sustained attack against Germany, which lasted exactly a year. This great offensive included three main battles. First, the Battle of the Ruhr and Rhineland, directed by OBOE, which enabled the Pathfinders to mark the aiming points with great accuracy. Immense damage was done to an industrial area of unique importance. Between the nights of Jly. 24 and Aug. 2, Hamburg received four very heavy and accurate attacks. The effects were catastrophic, and no city had ever been so extensively damaged, except by an earthquake. In August, the Battle of Berlin began, and continued with grim determination until March, 1944. The weather was generally bad, and it was not until the battle was nearly over that the full extent of the colossal damage, especially in the industrial areas, was revealed.

In March, 1944, it was judged that the strategic air offensive, the decline of the German air force, and attrition on the Eastern Front, had created the conditions needed for a successful invasion of the Continent. For the next three months

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* "The Strategic Air Offensive Against Germany, 1939-1945." By Sir Charles Webster and Dr. Noble Frankland. Vol. I, 522 pp.; Vol. II, 322 pp.; Vol. III, 332 pp.; Vol. IV, 530 pp.; 6½ in. by 9½ in. Illustrated with photographs, maps and charts. H.M.S.O. Price £2 2s. per volume.

Bomber Command was mainly employed in helping to destroy German communications and defences in preparation for the invasion. These targets were so thoroughly dealt with that the Allied armies were put ashore and established with small losses. The heavy bombers were used on numerous occasions thereafter in direct support of the armies, and in the attack of "V" weapons and their organization.

When Bomber Command returned to the attack of Germany in full strength, in the autumn of 1944, the air offensive was concentrated against two target systems—oil and transportation. This phase, as the authors point out, "*released the whole latent strength of the force which had been maturing for years. For Bomber Command it was a triumph. For Germany it was an irretrievable disaster.*"

By the beginning of 1945 Germany had little oil and its inland waterways and railways were blocked or reduced to chaotic inefficiency. Lack of oil hampered both operations and training, and Speer admitted that "*transport difficulties were decisive in causing the swift breakdown of the Ardennes offensive.*"

Damning with Faint Praise

The foregoing is a very brief summary of the narrative. The authors, in their introduction, say that "in many respects the story is a melancholy one." I do not think that it need have been. But they show none of the enthusiasm for their subject which is so apparent, for example, in Captain S. W. Roskill's excellent history of "The War at Sea." On the contrary, they seem happiest when describing, at great length, the mistakes and failures which certainly occurred. No sustained operation of this kind has ever been—or ever could be—free of many mistakes and failures. But most of them were due to factors outside the control of Bomber Command. As the authors themselves say, "*the initial failure and scarcely less the ultimate success were, in large measure, determined by the decisions of the pre-war years.*"

A great deal of space is given to detailed descriptions of controversies between the Air Staff and Sir Arthur Harris. Much is made of Harris' alleged obstinacy and bias, but too little is said about his great qualities as a commander. And whenever events proved, after all, that he was right, the admission is made with the minimum of grace.

After reading many pages of criticism and adverse comment, one is surprised to discover, from a brief sentence, that the operations under discussion were in fact a great success. This tendency towards animadversion has made it easy for those who wish to decry the strategic air offensive to pick out from their context and publicize damaging statements and reflections, while ignoring the main conclusions.

It has been widely claimed that the history condemns Bomber Command's operations as a failure and a waste of effort, but although it is true that it damns the Command with faint praise for a thousand pages, it ends on a very different note. In their concluding paragraphs, the authors have this to say:—

"*Strategic bombing and, also in other rôles strategic bombers, made a contribution to victory which was decisive. Those who claim that the Bomber Command contribution to the War was less than this are factually in error. . . . The achievement was basically due to a combination of conviction, leadership, invention and courage. . . . Sir Arthur Harris gave Bomber Command leadership which infused the force with a sense of purpose. . . . The scientists, technicians and designers provided the equipment and devices without which the courage of the aircrews would have been futile.*"

All very true; but, in the end, it was the unwavering courage of the crews of Bomber Command that made possible the final victory.

Beech Turboprop Developments

HIGHLIGHT of the 14th annual forum of the National Business Aircraft Assn. at Tulsa, Oklahoma, Sept. 26-28, came on the opening day, when representatives of Aero Commander, Inc., Beech Aircraft Corp., Douglas Aircraft Co., Inc., Swiss American Aviation Corp. and Turbo Flight, Inc., outlined their plans for the $250,000-$500,000 turbine-powered executive aircraft market. Beech Aircraft Corp., Wichita, Kansas, in an unexpected move, announced firm plans to proceed with development and production of a twin-turboprop executive transport.

Beech expect to market the complete aircraft, with all appointments for IFR operation but exclusive of optional equipment and electronics, at a basic list price of less than $400,000. Fully pressurized, the Beechcraft turboprop will seat six to eight persons and will cruise at more than 300 m.p.h. over 1,500 miles. Production deliveries of F.A.A. certificated aircraft are due in 1964.

Apart from being the first American twin-turboprop executive transport available for less than half a million dollars, the new type will also be the largest in the Beechcraft line. Its design has been based on market research conducted over the past six years, and is to be of all-metal, low-wing, tricycle-geared layout.

Napier Aero Engines—the New Board

FORMATION of Napier Aero Engines, Ltd., was announced in our issue of Jne. 8 last. Board of the new company, which is owned equally by D. Napier and Son, Ltd., and Rolls-Royce, Ltd., and will carry on the aero-engine business of D. Napier and Son, Ltd., has been formed as follows: J. D. Pearson, chairman; the Hon. George Nelson, deputy chairman; H. E. C. de Chassiron, managing director; the Rt. Hon. the Viscount Caldecote; F. T. Hinkley; Sir Archibald Hope, director of sales; A. A. Lombard; Sir John Paget, works director; A. J. Penn, technical director.

Mr. de Chassiron, 53, managing director, joined the English Electric Co., Ltd., in 1958 as assistant to the general manager of the company's nuclear power and heavy electrical plant divisions. He was elected to the board of D. Napier and Son, Ltd., and appointed managing director in September, 1960. He remains a director of D. Napier and Son, Ltd.

Arising from the foregoing, the board of D. Napier and Son, Ltd., has been reconstituted as follows: the Hon. George Nelson, chairman; G. A. Riddell, deputy chairman; P. J. Daglish, managing director; the Rt. Hon. the Viscount Caldecote; H. E. C. de Chassiron; P. Horsfall.

Mr. Daglish, 42, who becomes managing director of D. Napier and Son, Ltd., joined the English Electric Co., Ltd., in 1946, and gained a wide experience with the company as manager of the standards and specification section, deputy chief development engineer and, in 1953 as manager of a newly formed aircraft equipment division. He was appointed a special executive to D. Napier and Son, Ltd., in 1960, and commercial director early this year.

Marconi Board Changes

CHANGES in the boards of certain subsidiary companies have been announced by the English Electric Co., Ltd.

Marconi's Wireless Telegraph Co., Ltd.—The Hon. George Nelson has been appointed chairman of Marconi's Wireless Telegraph Co., Ltd. He succeeds Lord Nelson of Stafford who remains a director. Sir Gordon Radley has been appointed deputy chairman.

Marconi Instruments, Ltd.—Sir Gordon Radley has been appointed chairman of Marconi Instruments, Ltd., succeeding Lord Nelson of Stafford, and Mr. F. N. Sutherland has been appointed deputy chairman. Lord Nelson, the Hon. George Nelson and Mr. P. Horsfall retire from the board. Dr. E. Eastwood has been elected a director.

English Electric Valve Co., Ltd.—Sir Gordon Radley has been appointed chairman of English Electric Valve Co., Ltd., succeeding Lord Nelson of Stafford, and Mr. P. L. de Lazzlo has been appointed deputy chairman. Lord Nelson, the Hon. George Nelson and Mr. P. Horsfall retire from the board.

Marconi International Marine Communication Co., Ltd.—Lord Nelson of Stafford has retired from the board of directors and has been succeeded as chairman by Sir Gordon Radley. The Hon. George Nelson has relinquished the position of deputy chairman but remains a member of the board. Mr. R. Ferguson will retire from the position of managing director at the end of 1961 but will retain his seat on the board. Mr. D. P. Furneaux, the general manager, has been elected a director and is managing director designate.

Mr. H. E. C. de Chassiron.

Mr. F. T. Hinkley.

Aviation News in General

AUSTRALIAN CHOICE.—The Atar 9C has been confirmed as the final choice of the R.A.A.F. as the powerplant for its Mirage III fighters. Of the 30 Mirage IIIs at present on order, the first two will be supplied complete from France, and the remainder in the form of sub-assemblies to be put together by the Government Aircraft Factory at Fishermen's Bend. The Atar engines are expected to be built under licence by Commonwealth Aircraft Co.

ZERO HEIGHT THUNDERCHIEF.—An F-105D Thunderchief has made a 1,520-mile non-stop flight from Elgin A.F.B., Florida, to Nellis A.F.B., Nev., at between 500 and 1,000 ft. Disclosing this the U.S.A.F. said that only once did the aircraft climb to any height. This was for in-flight refuelling. Part of the flight included blind flying on radar instruments through the mountainous area of New Mexico and Arizona and also a simulated nuclear-bomb delivery.

LOAD LIFTER.—This Sikorsky project for a heavy assault helicopter utilizes the main and tail rotor and transmission systems now being produced for the S-64. It will be able to lift a 9-ton payload over short distances.

JET OTTER.—De Havilland of Canada is reported to have installed a 1,000-lb.-thrust Fairchild J83 turbojet internally in its special D.H.C.-3X Otter. This now has jet pipes on each side of its fuselage and is being used for low-speed trials. Also the aircraft has a four-wheeled undercarriage, extra large flaps and a number of other modifications.

TRAINER RECORDS.—Two new World records in the C-1-d class (jet aircraft of 1,750-3,000 kg.) have been claimed by the Soviet Union. On Sept. 30 a Yak-30 achieved an average speed of 767 km.p.h. (476.5 m.p.h.) over a 15-25-km. course, exceeding the previous best by about 10 m.p.h. The same aircraft on Sept. 25 attained a height of 16,128 m. (52,913 ft.), setting up a new altitude record. Previous height claim in this class was 50,024 ft. reached by a Macchi MB.326 on Aug. 4. The Yak-30 is presumably closely related to the Yak-32 illustrated in our Mar. 17 issue.

NEW BEECH.—An impression of the new low-cost Beech PD-169 four-seater, which is due to fly early next month. It is expected to sell for less than $12,000, f.a.f.

TURIN 1962.—Italy is to hold its first *Salone dell' Aeronautica* since the War from May 24 to June 3 at Turin next year.

PARLIAMENTARY CHANGE

Among the new ministerial appointments announced by the Prime Minister on Monday was that of The Hon. Christopher Montague Woodhouse, D.S.O., O.B.E., as Parliamentary Secretary to the Ministry of Aviation. He succeeds Mr. Geoffrey Rippon, M.P., who has become Joint Parliamentary Secretary to the Ministry of Housing and Local Government. Mr. Woodhouse is a specialist in international affairs. During the War he served in the Royal Artillery and was in command of the Allied military mission to Greek guerrillas in German-occupied Greece. From 1946 to 1948 he worked in industry. He became Director-General of the Royal Institute of International Affairs and Director of Studies in 1955—a post he held until 1959, when he became Member of Parliament for Oxford.

BOEING REORGANIZE.—A military aircraft systems division has been set up by the Boeing Company to consolidate activities of the Wichita and Aero-Space divisions in this field.

POTEZ SETBACK.—On Sept. 29 the prototype Potez 840 suffered slight damage when it landed at Toulouse with the undercarriage retracted. Damage was confined principally to the flaps, propellers and some of the skinning on the underside of the fuselage and nacelles. Repairs were expected to take about two weeks.

GULFSTREAM STRETCH.—F.A.A. approval has been obtained for a modification to the Grumman Gulfstream which increases the fuel capacity in the wing by 1,640 lb. to 12,100 lb. With the extra fuel the range is increased by 400 miles to 2,940 miles.

FEATURING THE X-15.—North American's X-15 rocket research aircraft is the "star" of a new United Artists film to have its London premiere next month. General release will be early in 1962. "X-15" is the title and it was filmed at Edwards A.F.B., Calif.

LOCKHEED PURCHASE.—The Grand Central Rocket Co., a producer of solid propellent rockets, has become wholly owned by the Lockheed Aircraft Corporation, who are to operate it as a separate division. Lockheed previously held a 50% interest in the company.

SPACESICK.—Soviet papers presented at the 12th I.A.F. Congress in Washington (Oct. 2-7) included one by O. G. Gazenko and V. J. Yazdovsky which disclosed that Major Titov was mildly "seasick" most of the time during his 25 hr. 18 min. flight in Vostok II. Despite this, he maintained a "sufficient level of working capabilities at all times." Worst effects "resembling seasickness" were when Titov turned his head sharply. No further technical information on the Vostok was given. Another Soviet contribution described "Some Results of the Constant Geomagnetic Field Measurements Carried Out from Sputnik III over the Territory of the U.S.S.R."

Commercial Aviation Affairs

ROME RECORD.—The air control centre for Rome, still located at Ciampino, has claimed a 15-month period free of any air miss reports being filed against radar. A TPS-1 surveillance radar has been in use at Rome for two years under the supervision of Mr. B. A. Turner, from the M.o.A. A Marconi 264A/H is to be installed next year.

OVERSEAS WOUND-UP.—Compulsory winding-up of Overseas Aviation (C.I.), Ltd., was ordered in the High Court on Oct. 9, on a joint petition of B.P. Trading, Ltd., and Rolls-Royce, Ltd. The company, registered in Jersey, was said to be in voluntary liquidation. Bankruptcy proceedings in the Jersey Royal Court were dropped last week because the company had virtually no assets in Jersey. A meeting of creditors of Overseas Aviation Engineering (G.B.), Ltd., on Oct. 4 agreed to the voluntary liquidation of that company.

HAMMARSKJOELD INQUIRY.—The four-man Board of Inquiry into the DC-6B accident in which Mr. Dag Hammarskjoeld lost his life is being led by Col. M. C. H. Barber, Director of Civil Aviation, Federation of Rhodesia and Nyasaland. The nine (originally 11) accredited observers and advisers includes one from IFALPA—Capt. A. G. McAfee.

ROYAL FLIGHT.—H.M. The Queen and the Duke of Edinburgh will fly to Ghana in a B.O.A.C. Boeing 707 on Nov. 9. The flight will be in command of Capt. John Woodman.

AIR CEYLON AGREEMENT.—B.O.A.C. has now confirmed the report (see our previous issue) of an agreement between it and Air Ceylon. From April, 1962, Air Ceylon will provide a weekly service with a Comet 4 on charter from B.O.A.C. on the route London-Colombo-Singapore. The aircraft will fly in Air Ceylon insignia and the service will be in pool with B.O.A.C. flights operated through Ceylon.

LONDON AREA CHANGE.—So as to provide lateral separation between inbound and outbound routes, to separate terminal and through traffic and to obtain additional airspace for radar-control manœuvring, the boundaries of the London Terminal Control Area and adjacent airways are being revised. The first stage in the revision comes into force on Oct. 26. Details are given in Notam No. 697, Sept. 26.

AIRPORT OPERATOR.—The Clyde Navigation Trust has informed the Ministry of Aviation that it wishes to own and manage the new Glasgow airport at Abbotsinch, to be opened in 1963.

HELIPORT OBJECTIONS. — The London Court of Common Council is to send a resolution to the M.o.A. declaring that a major heliport on the roof of Cannon Street Station would be unsatisfactory. Objections had previously been raised to the development of a heliport at Nine Elms, Battersea, and three days later the third (St. Katharine's Dock) proposal was opposed by the Stepney Borough Council.

EUROPEAN A.T.C. ASSOCIATION.—The inaugural conference of EFATCA (European Federation of Air Traffic Controllers Associations) is to be held in Amsterdam on Oct. 19 and 20. Thirteen national organizations are represented in EFATCA from Australia, Belgium, Denmark, Eire, Finland, France, Germany, Iceland, Luxembourg, the Netherlands, Norway, Sweden and Switzerland. The British GATCO is expected to join in the near future.

QANTAS PROFIT.—In the 15-month period to the end of March, 1961, Qantas recorded a profit of £A672,000, compared with £A854,000 in the previous 12-month period. The Qantas accounts are now made up to the end of each March to coincide with B.O.A.C. and Air India practice.

BRITANNIA HOURS.—Towards the end of this month, Bristol Britannias in airline service will complete 500,000 revenue flying hours. The average annual utilization rate for all civil Britannias is now about 2,850 hrs.

SKYWAYS EQUIPMENT.—Applications to the A.T.L.B. from Skyways Coach Air, Ltd., in respect of their services to Beauvais list as initial equipment the DC-3, Avro 748 and Constellation, with provision to introduce the DC-4, DC-6 and Argosy later.

VISCOUNT PURCHASE. — Aer Lingus has purchased a Viscount 808 from Maritime Central Airways; the only other Viscount 808—both originally built for Eagle Airways—is already in the Aer Lingus fleet. During the current summer peak Aer Lingus has been short of aircraft capacity and chartered two Viscount 708s from Tradair for two months.

FOND FAREWELL. — B.E.A. last month completed its last overhaul of a DC-3 at the Heathrow Maintenance Base. The last few Pionair Leopards in service with the Corporation are to be replaced by Argosies in November.

BOEING RE-ORDER.—Three more Boeing 720Bs have been ordered by Western Airlines for delivery in July and August, 1962. The company at present has four 720Bs in service in addition to two 707s which are leased from The Boeing Company.

ARGOSY OPERATION.—Making its first commercial freight operation in the U.S. an Argosy of Riddle Airlines on charter to South Western Bell Telephone Co. delivered five generators from Oklahoma to Austin, Texas, immediately after the hurricane Carla had caused extensive damage in the area.

LUFTHANSA JET PLAN.—Boeing 720Bs will be operated daily on Lufthansa's Frankfurt-London service from Nov. 1. On the same day Lufthansa will inaugurate a direct daily Viscount service between London and Bremen.

JET ANNIVERSARY. — The fifth anniversary of the first Soviet jet service was marked on Sept. 15. The captain of the first Tu-104 on the Moscow-Omsk-Irkutsk route, E. Barabash, flew the jubilee service and a ceremony was held to mark the occasion at Irkutsk.

DC-8 MODIFICATIONS.—Modifications to the DC-8 hydraulic system, developed jointly by Douglas and the F.A.A. and to be introduced as the aircraft are overhauled by the airlines, comprise: an increase in hydraulic reserve capacity; addition to reduce lead-causing pressures; a mechanical stop to prevent inadvertent use of reverse-thrust during landing. The F.A.A. is also to introduce additional checks on flight crews in emergency procedures and closer supervision of airline maintenance practices.

JERSEY TO NICE.—Jersey Airlines has inaugurated a Herald service once a week between Jersey and Nice.

LLOYD LOSS.—The DC-4 G-ARLF, total fleet of Lloyd International Airlines, Ltd. (registered in January this year), was destroyed by fire at Malaga on Oct. 8, when a refuelling bowser exploded.

(*Continued on page 503*)

News About People

M.o.A. DIRECTOR.—Air Cdre. F. E. Tyndall is to become Director of Electronics Research and Development (Air) at the Ministry of Aviation in November. He will succeed Air Cdre. A. G. P. Brightmore who has been appointed Director of Radio at the Air Ministry.

W.G.A. GUEST.—Admiral Sir Caspar John, First Sea Lord and Chief of the Naval Staff, was a visitor to the Coventry factories of Whitworth Gloster Aircraft, Ltd., on Oct. 2—the day the company's change of name became effective. He was there to see the state of development of the Seaslug Mks. 1 and 2 projects.

B.A.C. APPOINTMENTS.—New sales appointments announced by the British Aircraft Corporation are Mr. A. H. C. Greenwood to be manager, aircraft sales and service; Mr. D. J. Lambert to be technical sales manager (civil aircraft); and Mr. J. R. Ewans to be technical sales manager (military aircraft).

C.S.I.R. MEMBERS.—Five new members of the Council for Scientific and Industrial Research took office on Oct. 1, among them Mr. L. H. Bedford, director of engineering of English Electric's guided weapons division and Prof. O. A. Saunders, professor of mechanical engineering at Imperial College, London. Prof. Saunders served with M.A.P. during the War and was for many years chairman of the propulsion committee, Aeronautical Research Council. He is immediate past-president of the Institution of Mechanical Engineers.

BRISTOL SIDDELEY P.R.—Mr. Alex Johnston has left the S.B.A.C. where he was Press officer and later head of the information department to join Bristol Siddeley Engines, Ltd., as public relations manager. He assumes overall responsibility for the company's Press relations, advertising, exhibitions, films and the Bristol Siddeley Journal.

SPERRY APPOINTMENT.—On Oct. 1 Mr. F. A. Roberts became commercial manager of the Sperry Gyroscope Co., Ltd. He has been with the company since 1958 as contracts manager of its Bracknell division.

HEADING COLLINS RADIO.—Air Vice-Marshal G. P. Chamberlain became managing director of the Collins Radio Co. of England, Ltd., on Oct. 1.

A PIONEER'S BIRTHDAY. — M. Henri Potez, the French aviation pioneer, whose industrial interests take in central heating systems as well as aviation, celebrated his 70th birthday on Oct. 6 with a reception at the Heating, Ventilating and Air Conditioning Exhibition at Olympia. M. Potez was in London in connection with the exhibition.

Rear Admiral G. C. Ross who has joined Blackburn Aircraft, Ltd., as service liaison officer. Since the end of 1958 he has been with the Hawker Siddeley Aviation sales organization.

SPRAYMAT SPECIALIST. — Mr. G. E. Watkins has resigned his position of chief sales engineer with the de-icing equipment division of D. Napier and Son to take up an appointment with the Flight Support division of the Pacific Airmotive Corporation of Culver City, Calif.—Spraymat licensees in the U.S.

Air Transport

Trinidad Takes Over B.W.I.A.

THE Trinidad Government is, from Nov. 1, to take over the majority shareholding in British West Indian Airways, which is at present a wholly owned subsidiary of B.O.A.C. Associated Companies. The Corporation has (according to Trinidad sources) accepted a price of 2½ million West Indian dollars (about £520,000). It will maintain a 10% shareholding and one seat on the board of the airline.

The situation—which has been under discussion for several months and which was the subject of a report by a special commission headed by Sir Frederick Tymms (see our issue of June 22, p. 718)—has now been complicated by the secession of Jamaica from the Federation.

It is likely that Jamaica—which has been somewhat critical in the past of the policies of B.W.I.A.—will wish to be responsible for its own regional airline system. If a new Jamaican airline is, in fact, formed—whether independent, or as a subsidiary of some existing operator—the traffic-rights position may be changed.

Recent political events in the area may, too, have altered B.O.A.C.'s interests in the area. B.W.I.A.'s continued losses for B.O.A.C. (amounting to about £3½ million in 13 years) have, in the past, been shouldered largely because of the obvious advantages to the Corporation in having a firm foothold in the West Indies.

Independent Safety

RELEVANT statistics for the safety of operations by British independent operators—about which Parliamentary and public concern was evident this week—are difficult to obtain. The fact that the last three fatal accidents to British aircraft have been suffered by the independents, while the two Corporations have remained accident-free for three years, inevitably raises the safety question. The difficulty is to establish a fair yardstick by which the independent operators can be judged.

The international norm of "fatalities per 100 million passenger-miles" breaks down when applied to small charter operators. For instance, following the loss of its Dakmaster G-AMSW in the Pyrenees on Oct. 7 with 31 passengers and a crew of three, Derby Aviation can be said on this basis to have a safety record of probably more than 12 fatalities per 100 million passenger-miles, compared with the 1960 World average of 1.25. Derby had, on the other hand, operated for 21 years without a single passenger fatality, so this statistic is clearly unfair.

Any statistics which the Minister may produce as a result of pressure from M.P.s next week, will, it is to be hoped, be so devised as to take account of the primarily short-haul nature of most of the independents' flying.

For the record, there have been two accidents this year on independent charter flights: the Cunard Eagle Viking at Stavanger on Aug. 9, when 36 passengers and the crew of three were killed, and the Derby Dakmaster (a modified DC-3) last Saturday. There were no fatal accidents to British operators during 1960. In August, 1959, a Transair DC-3 crashed soon after take-off from Barcelona, killing 29 passengers and the crew of three. The last fatal accident suffered by either Corporation was in October, 1958, when a B.E.A. Viscount and an Italian Air Force F-86 were in collision over Anzio.

There have been, in recent years, a number of other incidents, in both independent and Corporation operations, which are relevant to any discussion of safety, although they have not involved fatalities. Perhaps the Minister will produce a list of landing incidents when British registered aircraft have hit obstacles on the approach or overrun the runway; such a list would show that the Corporations have their problems, as well as the independents.

A.O.A. Annual

MORE than 100 delegates attended the annual conference of the Aerodrome Owners Association—held last week at the Leeds Bradford Airport under the chairmanship of Alderman F. H. O'Donnell, J.P. The conference headquarters was established in Harrogate and the event was spread over two days during which papers of interest to all aerodrome owners were given.

Mr. J. M. Wilson, C.B., Deputy Secretary, Ministry of Aviation, dealt with the recent Government White Paper on civil aerodromes and air navigational services. Capt. J. A. Cameron of the British European Airways Helicopter Unit gave a useful talk on "planning the next stage" of helicopter operations and development in this country.

On the second day, a lucid and informing lecture was delivered on the economics of aerodrome management by Mr. R. F. S. Edwards, general manager of London's Airports. His paper dealt fully with present-day financial matters concerning Heathrow. Mr. G. H. G. Threlfall, managing director of Autair, Ltd., presented a comprehensive paper on past, present and future charter operations from the smaller U.K. airports for both passenger and freight traffic.

The conference ended with a visit to the Leeds/Bradford Airport at Yeadon.

A more detailed account of the conference will appear in next week's issue.

Air Versus Rail—The Wider Issues

THE Air Transport Licensing Board was invited last week to say clearly whether the development of British civil aviation should be its only concern, or whether the wider interests of the public at large should also be weighed. This issue is a fundamental one in the clash between B.E.A. and British Railways which developed at the continued hearing on Oct. 5 of the B.E.A. application to operate off-peak night services to Belfast, Edinburgh and Glasgow at a fare of £3 3s. single. The B.T.C. is the sole objector.

For British Railways, Mr. E. S. Fay, Q.C., expanded the point. There must be cases, he said, where the legitimate interests of air and surface carriers conflict, and where the public interest lies in the balance. If the A.T.L.B. could not weigh this interest, and balance the claims of air and rail, then there was no body short of Parliament itself which could do so. He did not believe that a proper interpretation of the wording of the Act restricted the Board in the way B.E.A. had suggested.

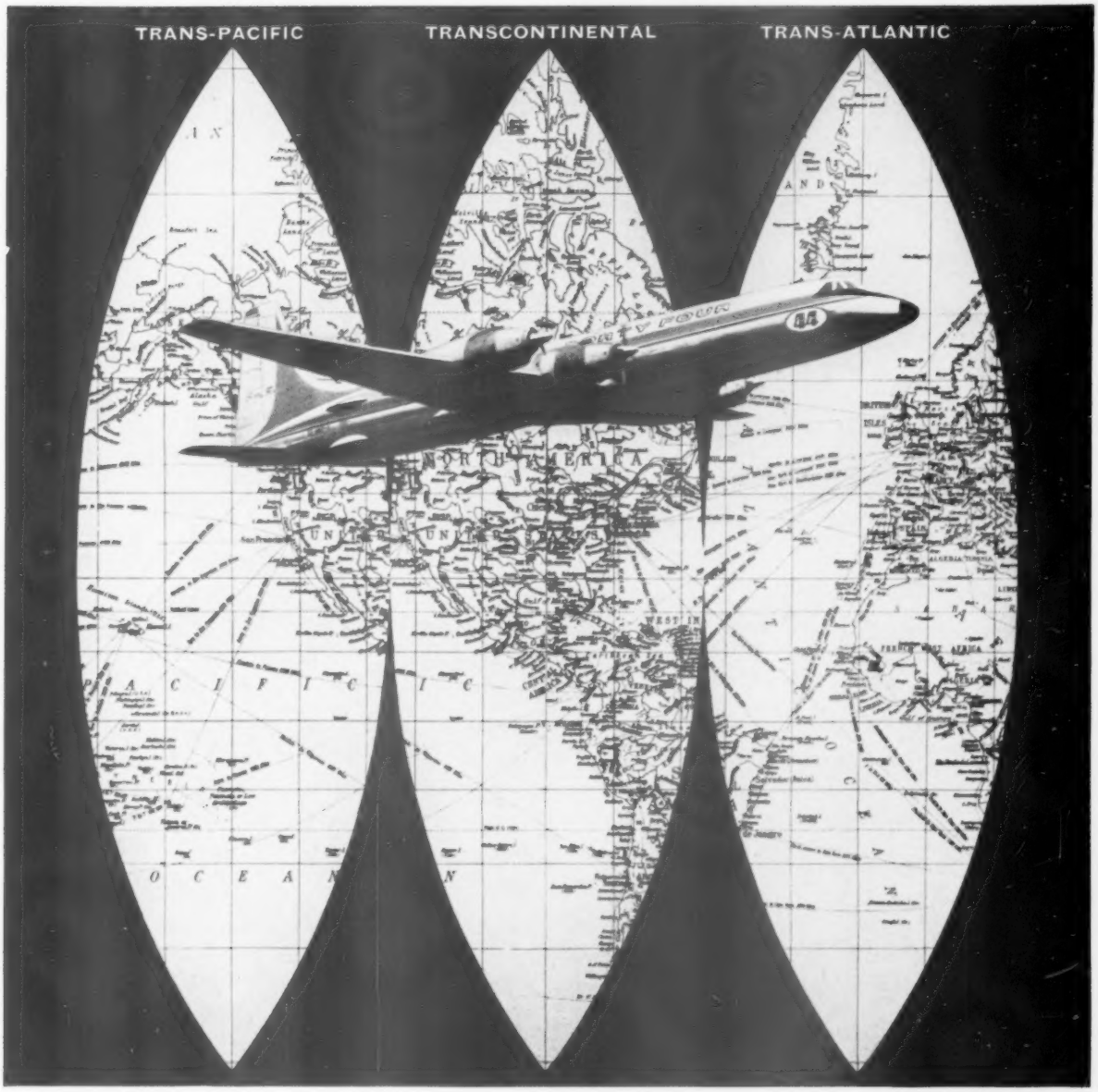
Evidence for British Railways was given by Mr. S. E. Raymond (traffic adviser). He made clear that the grounds of objection were that the proposed B.E.A. fare (which would undercut the standard second-class railway fare, but not the special fares available during the summer mid-week and on Friday nights) would take traffic away from the railways and, by damaging British Railways, was against the public interest. This point was not really in dispute—but its relevance was.

Some of the arguments advanced by British Railways seemed to do little to further its case. A good deal was made of the importance of a "timetable service" by which the public was assured of regular operation every day of the week, regardless of weather. On the question of the fares structure, the shift from rail to air travel of first-class passengers on these trunk routes was described as "proper transport progress," but the undercutting of rail fares by air for the bulk of the passengers would "not be in the public interest."

The British Railways' standpoint seemed to be that there were proper fare levels for road, rail and air transport regardless of their true relative costs. Air fares should not be allowed to come down below the rail level while rail fares should not compete, at the lower end of the scale, with road fares. This argument not unnaturally fascinated B.E.A. (in the person of Mr. Henry Marking) and also provoked some penetrating questions from the Board itself.

The Board also probed very thoroughly the British Railways' submission that no detailed statistics were available for its traffic on the routes concerned. Eventually a promise was obtained that British Railways would make an effort to provide any statistics that the Board might specifically request.

In answer to questions, Mr. Raymond made "a guess" that 75-80% of the total revenue on the Anglo-Scottish routes came from normal fares, 5-7½% from mid-week fares and the balance from excursion fares. He declined even to hazard this kind of estimate of the numbers of passengers using the services, but did say there is a trend away from first-class, chiefly in the summer months, and a general decline in the gross volume of traffic. About two-thirds of the total traffic was freight, and freight was, in general, more profitable than passenger traffic, although it was difficult to talk of profitability in the context of British Railways' operating losses of more than £1 million each week.



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In the light of current developments in Air Cargo, we challenge you to consider this statement: the time has come to make a searching reappraisal of air freight operations if they are being conducted with obsolete piston-powered passenger aircraft that have been converted for cargo use. We are convinced that these aircraft, although they may still represent a multi-million dollar book investment, should now be disposed of, notwithstanding current market prices, and replaced by the modern all-cargo Canadair Forty Four.

ARE YOU READY

Inevitably, the disposal will result in a "profitable loss," because it can be shown that the Forty Four is the only all-cargo aircraft able to operate at a profit, either domestically or internationally, under the new low freight rates. In a short period of time, the losses incurred on the sale of the outmoded converted equipment will be recovered by the swing-tail Forty Four. Any General Dynamics or Canadair official would welcome the opportunity to discuss this in more detail.

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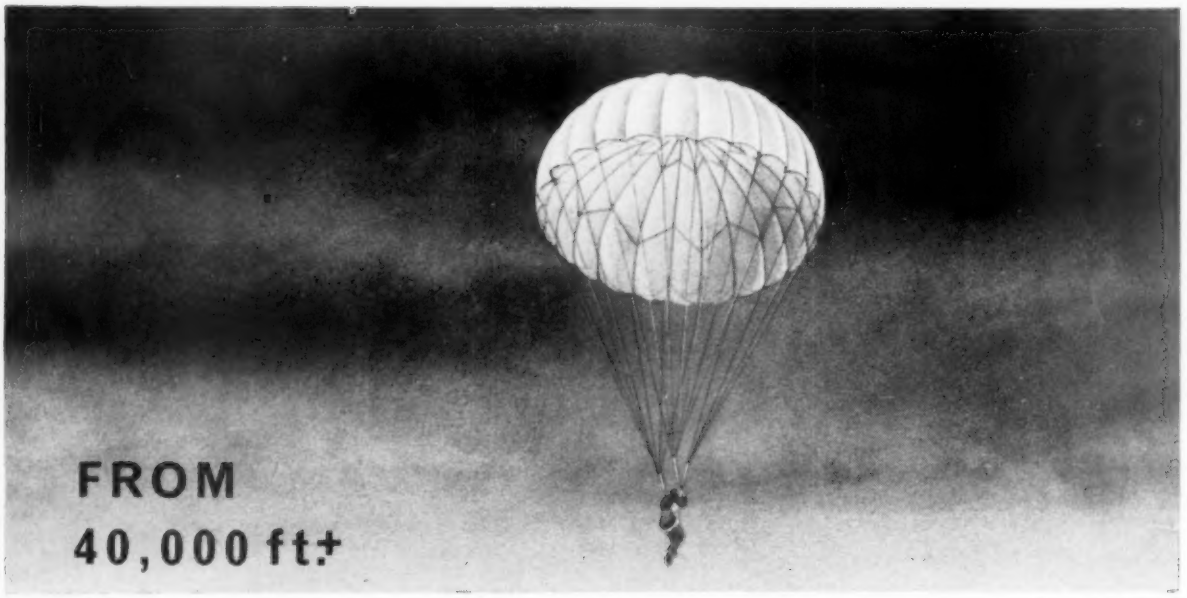

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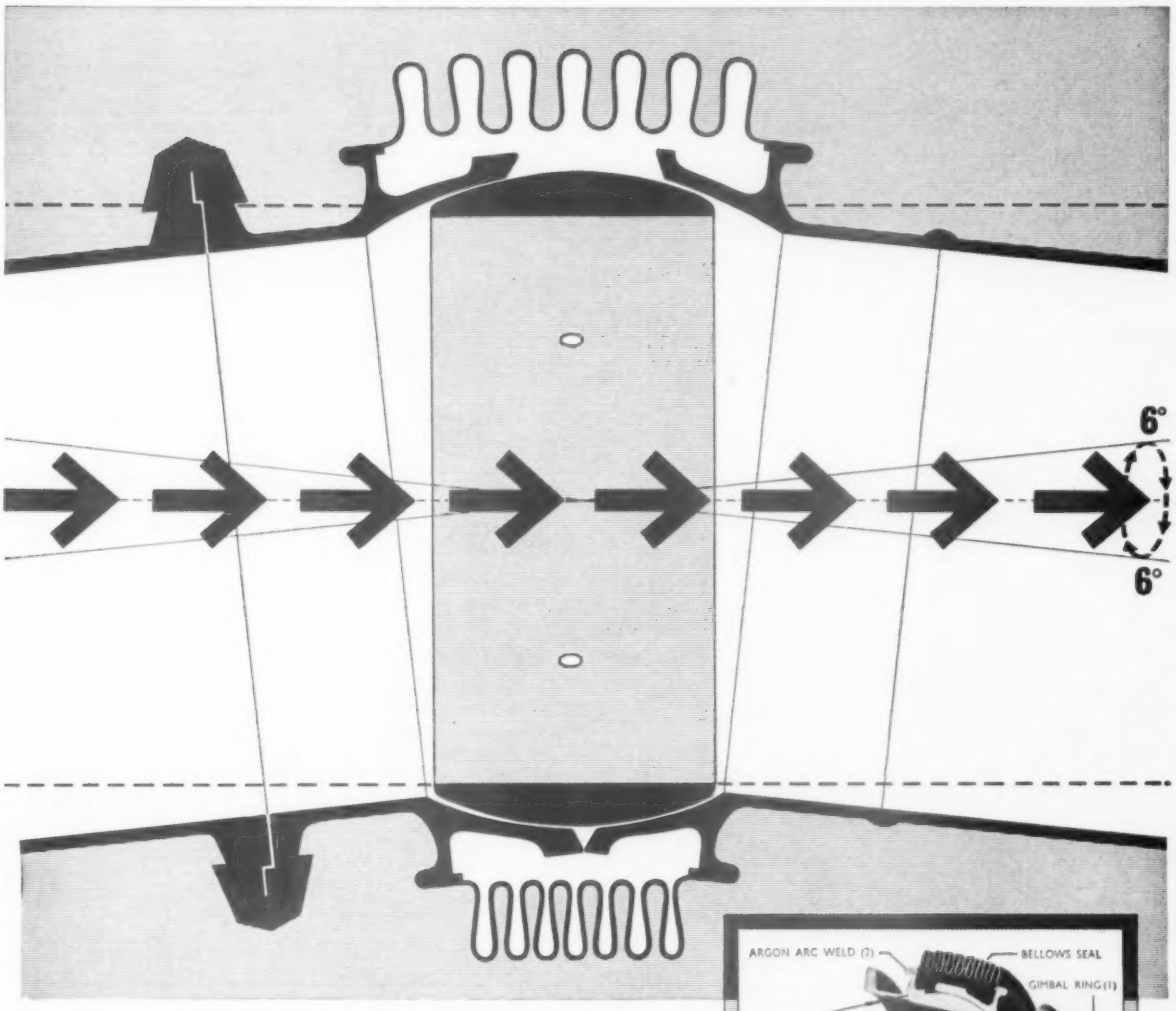

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DECCA IN DEFENCE

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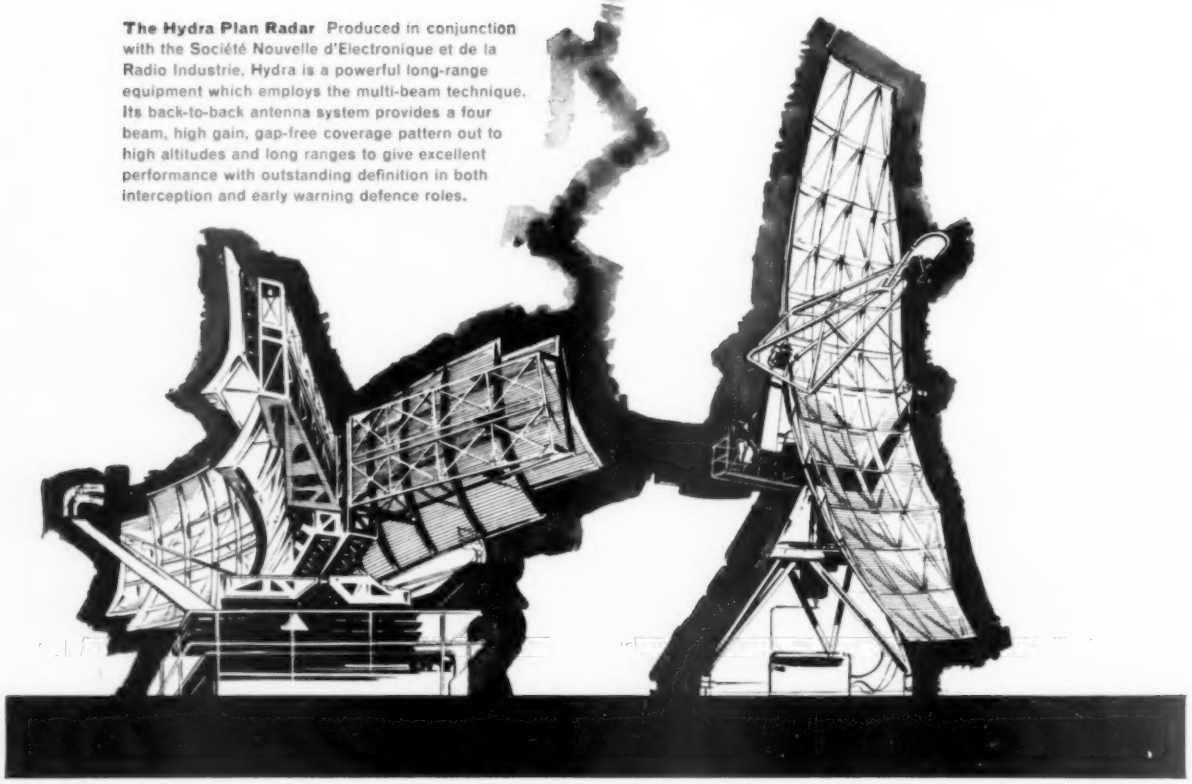
The Hydra Plan Radar Produced in conjunction with the Société Nouvelle d'Electronique et de la Radio Industrie, Hydra is a powerful long-range equipment which employs the multi-beam technique. Its back-to-back antenna system provides a four beam, high gain, gap-free coverage pattern out to high altitudes and long ranges to give excellent performance with outstanding definition in both interception and early warning defence roles.



These two radars, now in production for the British Government, are among the most advanced in the world — outstanding examples of the progress of Decca Radar in the fields of early warning and height finding air surveillance systems. Their design and performance, the results of years of operational and development work, are such that they provide early and full defence warning against the most modern aircraft — including those known to be under development.

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Air Transport . . . .

Supersonic Proceedings

THE International Air Transport Association has now published the proceedings of its Symposium on Supersonic Air Transport, as well as the complete working papers used by that session.

The 215-page volume summarizes the five-day discussions at Montreal last April, in which more than 600 specialists from airlines, manufacturers, governments and other interested organizations took part. The contents follow the pattern of the exhaustive preliminary questionnaire on which the Symposium was based, and review the current state of knowledge of supersonic aircraft possibilities.

A separate 1,200-page volume has been produced containing the working papers used by the Symposium.

Copies of the proceedings are available at $2.50 (U.S.) each, and of the working papers at $10.00 each, from the IATA Technical Secretariat, 1060 University Street, Montreal 3, Canada.

This is Economy?

ONE well-known airline (for Travellers With Appetites?) is now offering three-course meals to its economy-minded passengers on transatlantic flights. Starting with vegetable juice or shrimp canape, these meals feature grilled fillet mignon, parsley potatoes, tomato-shrimp-asparagus salad with French dressing; or breast of capon with wild rice stuffing, buttered green beans and sliced carrots; or (Fridays only) lobster Thermidor. Each meal is rounded out with rolls and butter, apple pie, Cheddar cheese and freshly made coffee.

These menus are offered to travellers taking advantage of the lowest IATA fares on Atlantic routes—the 17-day excursions available from now until next March.

Economy class was introduced over the North Atlantic 3½ years ago. Those with long enough memories may recall some of the conditions then laid down: as, for instance, that the cabin service should comprise "simple, cold, inexpensive sandwich meals." No hot food was to be served. There followed "the battle of the sandwich," with victory eventually going to the proponents of the succulent Scandinavian open sandwiches.

The abolition, in April, 1960, of tourist class opened the way for a further improvement in the service offered to economy passengers, and the reintroduction of hot meals was inevitable. Now the Lucullian wheel has come full circle.

Footnote. U.S. airlines lost $6 million on international services in the first six months of this year.

Domestic Freight Tariff Freedom

TO encourage the development of air freighting within the U.K., the Air Transport Licensing Board is proposing to abolish all tariff provisions for the domestic carriage of freight. This proposal, which is subject to final promulgation after any objections or representations have been made, is the first example of a spontaneous action by the Board under the powers given it in Section 3 (3) of the Act, to revoke, suspend or vary any air service licence on its own initiative.

The Board has enumerated, as follows, five reasons for its decision:—

(1) The general duty laid on the Board by Section 1(1) of the Act of exercising their functions in such a manner as to further the development of British civil aviation.

(2) The increasing awareness in industry and commerce that air transport is sometimes the most effective way of meeting the commercial requirement and national need that freight should be carried as efficiently and economically as possible.

(3) The consequent growth that is to be expected in the demand for air freighting facilities.

(4) The intention of many licence holders to increase domestic freight capacity as an incidental to the increase of capacity of passenger services, and their consequent wish to be free to follow an aggressive policy of cargo sales development.

(5) The intensive and unregulated competition encountered by licence holders from surface carriers.

At the present time, 21 airlines (B.E.A. and 20 independents) hold air service licences which allow them to fly freight on domestic routes. All these licences would be amended by the A.T.L.B.'s decision, to delete the existing tariff provision, and in future licences would be issued without stipulating the rates to be charged.

OPtional Reading—15

IT will take a few more numbers of OPtional Reading to deal with the landing problem. However, I make no apology for this; undershoot and overshoot accidents represent the largest source of catastrophe in aviation and it seems to me that someone should be hammering away at them. As a matter of fact, I am not keen on taking up the job; to say the least, one is sticking one's neck out. So, if anyone can put me in touch with a standard work on the landing of modern jet aircraft, written in language a plain pilot can understand, I will be glad to devote the next few numbers to quoting suitable excerpts from it. However, so far I haven't been able to find such an authority.

A certain amount of skirmishing with the problem has, of course, gone on. I mentioned, in OPtional Reading 2, the work of the ICAO Visual Aids Panel in developing specifications for the Visual Approach Slope Indicator; this will undoubtedly assist the pilot to maintain a steady approach angle and it should therefore make a definite contribution to the reduction of undershoots due to visual misjudgments. However, as already indicated in OPtional Reading 4, it is my belief that most of the undershoots are not due to visual misjudgments but to speed misjudgments (including rate of sink, which is closely related to speed).

Another approach to the problem has been made by Otto Kirchner of Boeing, working under the sponsorship of the Flight Safety Foundation. Here again, if I recall his interim report correctly, he places the main emphasis on visual misjudgments and there is no analysis of the aerodynamics applying at the final stages of approach. He did, however, provide some very useful statistics to show that the majority of landing accidents do in fact occur round the final stage of approach or in the overshoot area. (In later numbers I will endeavour to show that these apparently antithetical results are due to the same basic cause.) But valuable though the studies were, I prefer to take the attitude of the West Countryman giving advice to the motorist: "Well, zur, if oi wur goin' to Muddlecombe, oi w'u'n't start from 'ere at all!"

I would start, and have in fact started, at some aerodynamic datum and, for landing purposes, that is the stall. I have shown (OPtional Reading 12) that, by adopting an unconservative definition of the level-flight stall, a certification value of 100 kt. for the landing configuration can, and often will, be about 4 kt. short of the "fall-out-of-your-hands-speed"; I have shown (OPtional Reading 13) that, whereas the propeller-driven aeroplane had, at the threshold, about a 36 kt. margin (1.3 Vs less 4 kt. error plus 10 kt. slipstream) for the round-out or flare manœuvre, the jet has lost the 10 kt. slipstream and is down to a 26 kt. margin above the true (fall-out-of-your-hands) *level flight* stall.

But the round-out is not level flight; in this manœuvre, as in a horizontal turn, added *g*-forces are applied, and these affect the stall very directly. For a horizontal 60-degree banked turn, the effective weight of the aeroplane is doubled and the stalling speed increased correspondingly. The only acceleration figures I have hit on for the round-out manœuvre—namely between .2 and .4*g*—are for piston-engined aircraft, but I see no reason why the jet should be much different, the difference in flight profile and in speed not being significant for this purpose. If we take the mean figure, .3*g*, a landing weight of 150,000 lb., a wing area of 2,500 sq. ft., becoming 3,000 ft. with full flap, a 100-kt. certification (104-kt. actual) stalling speed and (if my aerodynamics are good enough) a stalling speed at the bottom of the round-out proportional to the square root of the wing loading—then the aeroplane will fall out of your hands at 118 kt. on the clock—assuming no airspeed errors.

So the effect of the jet round-out manœuvre, if carried out at 1.3Vs, is to reduce our margin, which the book said was 30 kt., to about 12 kt. you will now see where we are getting—pretty near the "mush point"—but of that more anon.

Of course, I am courting refutation by the boffins; probably they would prefer to throw away all discussion on the basis of speeds and would produce elaborate equations on the basis of lift and angle of attack. But the angle of attack represents a difficult concept when applied to a curved flight profile; moreover, the pilot landing an aircraft flies by his eyes, his airspeed and—I avoid the natural alliteration—the seat of his pants. So I propose to keep to airspeeds and *g*-loadings, crude though the expert may consider them; after all, some will recall at least one very good precedent in the field of analytical accident investigation for keeping the terms down to such simplicity that the calculations can be done on the train, preferably on the back of an envelope!—C.C.J.

INDEPENDENT TURBOJETS.—The news of the plans for an eventual merger of the two big French independent carriers, T.A.I. and U.A.T. (see last week's issue, p. 448) adds interest to this impressive picture of Orly Airport, Paris, with two of T.A.I.'s three DC-8s on the apron. The aircraft on the extreme right is a Yugoslav Airlines Convair.

Air Transport . . . .

A.T.C. Cadet Scheme

AN officer cadet scheme for civil air traffic control is to be introduced by the Ministry of Aviation. School leavers who meet the necessary education requirements—G.C.E., with passes in five subjects, one of which must be English and two (including mathematics or a scientific subject) must be advanced level—will, if successful in interview, undergo full-time, paid training for a period of four years at the A.T.C. School at Hurn, Bournemouth. The course will include some flying instruction.

The scheme is being introduced because the present sources of supply (men with a background of flying experience) are unlikely to be adequate for future needs.

The first intake of cadets is due to start training in February next year.

Lessons From an Accident

PILOT error is given as the immediate cause of the accident to an Electra at La Guardia in September, 1960, in the report of the C.A.B. investigation. All occupants of the aircraft —which came to rest inverted and caught fire—escaped from a situation which, says the report, "at first looked completely hopeless."

Several important lessons were learnt from the incident, as a result of which the C.A.B. recommended, on Sept. 22 (only eight days after the crash), that visual glide slope indicators should be installed at La Guardia as soon as practicable. [This has now been done.] In December, the F.A.A. was further recommended to re-examine procedures for illuminating passenger-exit markings in transport aircraft.

The Electra, owned by American Airlines, was being flown by Capt. Sheldon E. Pangburn from the left-hand seat; he is a company check pilot and had boarded the flight 10 minutes before take-off from Boston to conduct a semi-annual check on the flight engineer. In accordance with agreed procedure, the captain assigned to the flight moved to the jump seat to make way for Capt. Pangburn. The investigation revealed no malfunctioning of aircraft, engines, or equipment, and no infringement of company or F.A.A. rules for its operation.

The landing was to be made on La Guardia's 13/31 runway, which is 5,347 ft. long, but which was limited to 4,900 ft. on the day in question by work at the farther end. The minimum effective runway length required by the Electra was 4,010 ft. Captain Pangburn testified that he was attempting to land short and made a normal approach; the report notes that the work in progress on the runway may have created a "mental hazard" providing a motive for making a short landing.

At a distance of 161 ft. from the approach end of the runway stands a dyke, projecting 8.2 ft. above runway level and 13.7 ft. above mean water level on the other side. All four main wheels of the Electra struck the top of the dyke, and a study of the marks made revealed that the undercarriage was 1.3 ft. below the top of the dyke at the time of impact, and that the aircraft was 0.2 degrees right wing down.

After initial impact, Nos. 1 and 2 propellers struck the ground 131 ft. farther on (i.e., just short of the runway), and the aircraft rolled to the left on to its back. The left wing, partially detached by the initial impact with the dyke, was torn off; fire started in this wing, and, during the roll-over, in the right wing also.

When the aircraft came to rest, 1,000 ft. from the dyke, the passengers were hanging upside-down by their safety belts, and the interior was darkened by mud and soot on the outside of the windows. Evacuation began through the rear lounge door; the buffet service door was opened from the outside, and one emergency exit was opened by a passenger who subsequently opened a window in the cockpit and helped the crew out. All 70 passengers and two stewardesses left in approximately three minutes, using three of the five available exits.

The report does not say why the other exits were not used, but, by implication, the emergency windows may have been difficult to find in the semi-darkness.

An Airline's "Corporate Identity"

THE rarely considered but important problems involved in the development, and successful maintenance, of an airline's "corporate identity" were discussed last week in a paper read by Mr. Anthony Milward, chief executive of B.E.A., at the 1961 International Design Congress in London.

He said that the product which an airline sells is "not only intangible in the sense that it is a service, but it is also consumed over a considerable length of time and in a number of different places" where the passenger should "be able to recognize that he is in the hands of the same airline." So "the most important feature of a corporation's house style . . . is that it should be coherent."

Mr. Milward explained the way in which B.E.A.'s own house style has been and is being developed and how it is "communicated" to all levels.

Gold rush '61

From Rome to the gold-rich Rand. Alitalia's long-range DC-8's, powered by Rolls-Royce Conway engines, cover in hours distances that took the overland trekkers months. Pre-war pioneers of 'bush pilot' operations in Africa, Alitalia now operate in 41 countries, providing a network of 93,000 route miles reaching almost around the world. At both ends of Alitalia's trans-African service it is AIR BP who provide the fuelling service: at Fiumicino by the latest highly efficient hydrant system, at Johannesburg by tankers capable of delivering thousands of gallons in a matter of minutes.

Fast flying ALITALIA... fast fuelling AIR BP

DOWTY

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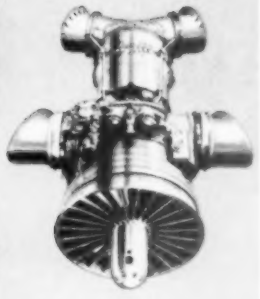
- HYDRAULIC PUMPS AND JACKS
- CONTROL LIFT FANS
- AIR TURBINES
- SERVO VALVES
- SEALS AND MOULDINGS

Companies of the Dowty Group, Europe's largest manufacturer of aircraft equipment, are associated with the majority of new projects in the civil, military and cargo fields.

The Hawker P1127 is fitted with Dowty Rotol undercarriages, steerable nosewheel unit and a Dowty fuel control system is part of the revolutionary Bristol Siddeley 'Pegasus' engine which powers the aircraft.



The Vickers VC10 uses Dowty Rotol ram air turbines.

English Electric Lightnings rely on Dowty Rotol undercarriages, nosewheel steering, air turbines, and hydraulic systems.

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Air Transport . . . .

CHANGE OF SPOTS.—Two Britannia 102s, chartered for two years from B.O.A.C., are now operating in B.U.A. colours (top picture), principally on trooping flights. The lower picture shows a B.U.A. Viscount in B.O.A.C. colours, for operation of the Corporation's Skycoach services to East Africa.

Jordanian Starts Operations

JORDAN AIRWAYS, the formation of which was first reported in our issue for Sept. 28 (p. 421), began operation on Sept. 29 with special V.I.P. flights, followed by scheduled operations on Oct. 1. It has adopted the name Jordanian under which to operate, and is hire-purchasing two Viscounts and a DC-3 from Middle East Airlines. These aircraft have now been repainted in Jordanian livery, and are operating on the routes Amman-Damascus-Beirut; Amman-Jerusalem; Amman-Jerusalem-Cairo and Amman-Jerusalem-Kuwait. The schedules are integrated with those of Middle East Airlines and provide, amongst other things, for a combined frequency of two services a day between Amman and Beirut.

Middle East Airlines is providing technical and operational assistance to Jordanian, including crews for the aircraft and maintenance facilities. The Lebanese company has taken a 35% interest in Jordanian, in a move which is in keeping with its announced eagerness to foster the creation of a Pan-Arab airline.

The Future of M.E.A.

MIDDLE EAST AIRLINES, which severed its link with B.O.A.C. on Aug. 16 (see our issues for Aug. 17 and 24), has increased its capital from £L6,250,000 to £L15,000,000. The additional capital was raised by sale of shares on the open Lebanese market.

Expansion of M.E.A. routes is expected to follow the airline's acquisition of independence. One of the immediate objectives is to obtain route rights for a service to Rome and Madrid; these were not forthcoming last year because the Spanish and Italian Governments were not prepared to grant additional rights to what they regarded as a British company. M.E.A. is also planning services to West Africa, where there are Lebanese emigrants, and hopes eventually to serve South America, where there is a very big Lebanese community.

Sheikh Najib Alamuddin confirmed in Beirut recently his wish to see the four existing Lebanese airlines merged into a single United Lebanese Airline. All but one are now free of foreign participation, and the future of that one is at present under discussion with its foreign shareholders. A committee has been appointed under the chairmanship of the Minister of Public Works and Transport to study the operations and activities of all the Lebanese airlines, and to make recommendations to the Government.

Additional details have been given by the Sheikh of the financial arrangements involved in M.E.A.'s independence. As already reported by us, B.O.A.C. held 24,216 £L100 shares in M.E.A., representing 48.43% of the basic capital. These have been purchased for cash by a number of Lebanese nationals. In addition, M.E.A. is repaying loans totalling £1.5 million which were made by B.O.A.C. to provide working capital after the heavy losses in 1958. These loans will be paid off in equal instalments over five years, and are covered by an Intra Bank guarantee.

M.E.A. still has four yearly instalments to pay in respect of its Viscounts, which are being purchased from B.O.A.C. These payments will be made as originally planned. The four Comets are being purchased directly from de Havilland; B.O.A.C. originally put up a guarantee for this purchase, and M.E.A. has now given B.O.A.C. a mortgage on the aircraft against this guarantee.

All the installations of MASCO (Mideast Aircraft Service Co.), comprising land, buildings and equipment, have been bought by M.E.A. with an initial cash down payment and instalments to be paid over the next 10 years.

Problems of Airport-City Travel

AIRLINE passengers in four principal U.S. cities (Washington, New York, Chicago and San Francisco) spend from 22% to 65% of their total journey time in getting to and from the airports. A recent survey conducted for the F.A.A.* holds out little hope of improvement, and indicates that air passenger volume will double by 1968, airports will be located farther from cities and ground travel congestion will increase in all forms.

The report notes that because airport-generated ground traffic represents less than one per cent. of the overall traffic volume of the four cities surveyed, it receives little attention from the metropolitan highway agencies. On the other hand, airlines generally do not regard air terminal commuting as being their responsibility either.

The problem is aggravated by the preference of passengers for using their own cars or taxis rather than trains or buses. The "ever-widening circles of suburbia" place the passenger farther from the airport and at the same time force the airports to "retreat from the centres of passenger origin and destination."

Mass transport methods (bus, train, or helicopter) are indicated as means of reducing ground-transportation times. The problem is regarded as sufficiently serious to threaten the survival of short-haul airlines.

* "Airport Transportation—A Study of Transportation Means between Airports and the Metropolitan Areas they Serve," by Human Sciences Research Inc. for F.A.A. Order PB 171 856-7 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. Price $5.

Air Transport . . .

HONG KONG'S AIRLINE

Cathay Pacific Airways' two Electras are now back in service after modification, in the new livery seen here.

PERHAPS the only thing more forlorn than a deserted airfield is a list of airlines started by Servicemen after the War. One of the relatively few which is large and successful is Cathay Pacific Airways, a regional airline based in Hong Kong. Special interest attaches to Cathay's operations because of the impact which the big jets are having on these, and because the airline is one of the largest of the non-IATA carriers.

The company was started in 1946 by Roy Farrell and Sydney de Kantzow, two former Dakota pilots of the Calcutta-Chungking "Hump." Their first DC-3 freighter (sold only a couple of months ago) was soon joined by six others, operating to Shanghai and throughout the Far East. In 1948 Australian National Airways (since merged with Ansett) and Butterfield and Swire, the British shipping and trading firm, acquired a controlling interest, and scheduled services were started. By 1954 the network ranged from Hong Kong to Singapore, Borneo, Bangkok, Indo-China and the Philippines.

Fares were then 20% below those of IATA carriers, but this discount did little to attract passengers, and was ineffective in gaining interline business because of the absence of pro-rata agreements. With the purchase of a 58-passenger DC-6, fares were voluntarily raised. About the same time the China Navigation Co. and the P. and O. line became major shareholders; their holdings are now combined with those of Ansett-ANA and Butterfield and Swire in Cathay Holdings, Ltd., which owns 84.5% of the airline's stock.

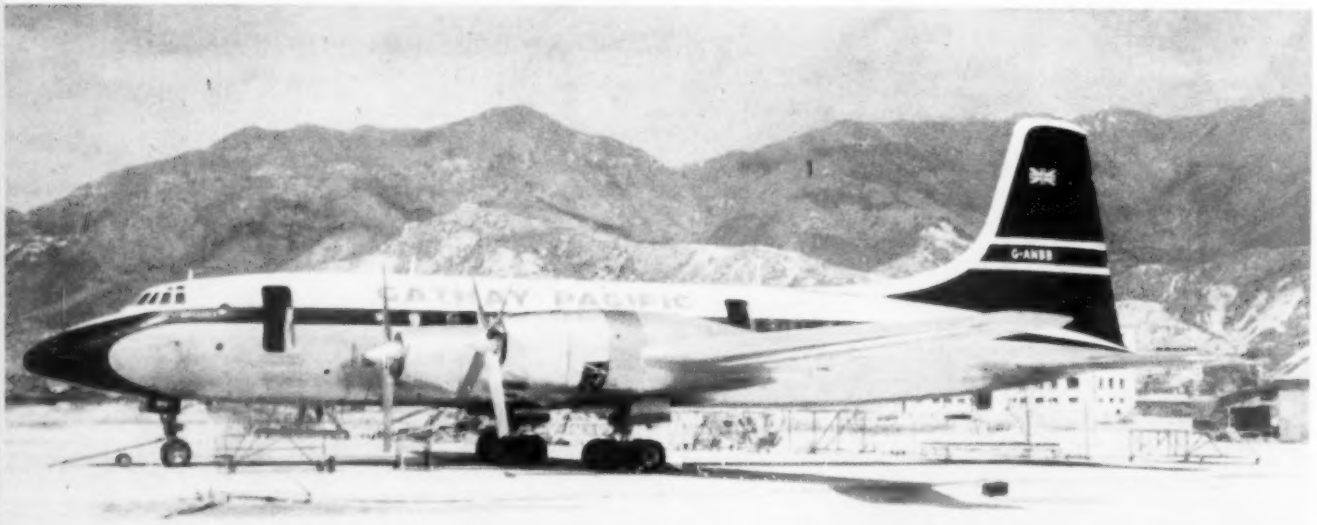
In 1958 Cathay acquired Hong Kong Airways from B.O.A.C. Associated Companies, which thus has a 15% interest in Cathay. With the merger came new route rights to Taipei, Seoul, Manila and Tokyo; other services had by then been extended to Rangoon, Calcutta, Vientiane, Kuching, Phnom-Penh and Kuala Lumpur.

With capital of £625,000, the company is not in a position to invest in big jets, although the numerous models in the commercial director's office testify to the optimism of the manufacturers. The airline's present equipment includes a DC-4, a DC-6, a DC-6B and two Electras. Even the purchase of the Electras was no light affair—nor was the cost of chartering a Britannia, with crews, while the Electras were being modified. Although the Electra accidents had less passenger impact in the Far East than in the U.S.A., the turboprops have suffered from jet competition. This has forced the abandonment of the non-stop Hong Kong to Tokyo service, only recently reinstated. Moreover, the increased capacities of the jets has reduced the amount of interline business—once 40% of Cathay's total volume.

Meanwhile, Cathay has not been idle. It has been active in tourist promotion, and has been working with the Indian Airlines Corporation to develop interest in Kashmir. As a regional airline, covering a relatively limited area, Cathay can afford higher frequencies than the major international operators. Its departure times can be convenient to local conditions and, because aircraft come from nearby, the services are normally more punctual than those of long-haul carriers.

Aircraft released by the purchase of the Electras are being chartered outside Cathay Pacific's area with a target of 160 hours per month. Shipping companies are the principal customers in this competitive market.

Cathay has no ambitions for large-scale expansion. It is content to consolidate its position as a major regional carrier in the Far East, and to improve services and frequencies. A twice-weekly operation to Sydney was started last February and Djakarta became the 17th major C.P.A. route point on Sept. 7. In the same week, joint services to Kuala Lumpur and Singapore were started in co-operation with Malayan Airways, using a chartered Britannia.—N.A.M.



While the Electras were out of service, Britannias were chartered from B.O.A.C. and flew Cathay Pacific colours. G-ANBB is seen here at Kai Tak Airport.

The Fighting Services

No. 60 Squadron Crest

A FORMER N.C.O., Ken Hayes of Leicester, was recently flown out to R.A.F. Tengah, Singapore, to present to its owners, No. 60 Squadron (Wg. Cdr. P. Smith), the original crest signed by the late King George VI.

The guest of the Squadron for a week, Mr. Hayes, who saved the crest during the Japanese invasion of Burma, toured the station and met the C.-in-C., Far East Air Force, Air Marshal Sir Anthony Selway, and the A.O.C., No. 224 Group, Air Vice-Marshal Ramsay Rae. He also reviewed the troops of No. 60 Squadron in an unusual parade attended by the C.-in-C.

R.C.A.F. CH-113 Helicopters

SIX Boeing-Vertol 107 twin-turbine-powered helicopters have now been ordered for the R.C.A.F. Designated CH-113s, they will be used mainly in the search and rescue rôle. Delivery of the first two aircraft, ordered earlier this year, is scheduled for 1962.

The CH-113s will be capable of carrying external loads of up to 10,000 lb. with a special cargo hook which can be stowed in the helicopter's cargo compartment when not in use. With the aid of extended, large-capacity fuel tanks yet to be designed, the R.C.A.F. aircraft will be able to carry a 2,000-lb. payload more than 650 miles without refuelling.

All six helicopters will have the tandem-rotor system, rear-loading ramp and built-in flotation of the 107. Powered by General Electric T58-8 turbines, they will cruise at 150 m.p.h., have seats for 26 fully equipped troops, or accommodate 15 stretcher patients.

To operate at a maximum all-up weight of 18,700 lb., the CH-113s will be flown by a two-pilot crew. They are to have an intercom. system which can be lowered to establish communication between the helicopter and the personnel to be rescued. They will also have a radar system for search and rescue work, and will have a 600-lb. capacity cargo and personnel hoist which can be lowered through a rescue hatch in the centre of the cabin floor.

Near East Aerobatics

LED by Sqn. Ldr. B. P. W. Mercer, "The Blue Diamonds" aerobatic team of No. 92 Squadron is to give displays in Persia later this month. Expected to leave their base at Leconfield today, the Squadron's Hunter F.6s will fly to Cyprus by way of Malta, and then go on to Meherabad, Tehran.

The groundcrews will fly from the United Kingdom in a Britannia of Transport Command, and locally in a Hastings of the Near East Air Force (Cyprus). On Oct. 20 the team will give a display at Meherabad on the occasion of the Iranian Air Force Day, and return to Nicosia on Oct. 21.

Trans-African Expedition

LAST Monday, Oct. 9, nine officers and men of the R.A.F. Trans-African Expedition left Farnborough for a 53-day journey to R.A.F. El Aden, near Tobruk. Led by Wg. Cdr. G. Turnbull and equipped with three Land-Rovers and a motor-cycle, the party is expected to cover a total of 8,200 miles.

After crossing France and Germany, they will face 6,400 miles of unsurfaced roads, including 500 from Dongola to Kufra Oasis, known only to Sudanese camel drivers. Wg. Cdr. Turnbull considers the expedition to be adventure training but will also give valuable desert experience to the members who may crash land in the desert or lead rescue teams there.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Gp. Capt. I. G. S. Hemming, C.B.E., to the Department of the Air Member for Supply and Organization.

Bomber Command: Wg. Cdr. O. B. Balean, L.D.S., to Headquarters (Unit) as Senior Dental Officer; Sqn. Ldr. F. E. Zaccheo to R.A.F. Driffield to command the Administrative Wing, with acting rank of Wg. Cdr.

Coastal Command: Wg. Cdr. E. J. Booker, M.M., to R.A.F. North Front, Gibraltar, as Senior Technical Officer.

R.A.F. Germany: Gp. Capt. E. H. Lynch-Blosse, O.B.E., to Headquarters for staff duties; Wg. Cdr. P. Dobson, D.S.O., D.F.C., A.F.C., to Headquarters for work study duties; Wg. Cdr. G. Strange to R.A.F. Wildenrath to command No. 88 Squadron; Sqn. Ldr. J. H. Misselbrook to Headquarters as Chief Air Traffic Control Officer, with acting rank of Wg. Cdr.

F.E.A.F. CEREMONY.—As recorded on this page, Ken Hayes, a former N.C.O., recently presented No. 60 Squadron with its original crest. He is seen here with the C.-in-C., F.E.A.F., Air Marshal Sir Anthony Selway (right) and the A.O.C., No. 224 Group, Air Vice-Marshal Ramsay Rae, after the ceremony at R.A.F. Tengah.

Near East Air Force: Wg. Cdr. V. H. Hemming, M.B.E., to R.A.F. Akrotiri to command the Administrative Wing; Wg. Cdr. K. S. Law, to Headquarters for organization duties; Sqn. Ldr. W. G. Chesterman to R.A.F. Akrotiri as Wing Commander, Personal Services, with acting rank of Wg. Cdr.

Air Forces Middle East: Wg. Cdr. L. Rose to Headquarters for technical co-ordination duties.

Far East Air Force: Wg. Cdr. P. C. Ellis, D.F.C., to R.A.F. Gan to command; Sqn. Ldr. D. H. M. Chandler to R.A.F. Tengah to command the Administrative Wing with acting rank of Wg. Cdr.

Other Appointments: Wg. Cdr. R. B. Langlois, D.F.C., to the Ministry of Defence; Wg. Cdr. F. E. Lord, A.F.C., to Supreme Headquarters Allied Powers Europe as Staff Officer, Organization and Training; Sqn. Ldr F. R. Pusey, M.B.E., to the British Defence Staffs, Washington, with acting rank of Wg. Cdr.; Sqn. Ldr. W. J. Wightwick to the NATO defence college for studies, with acting rank of Wg. Cdr.

More Service News

Air Council Dinner.—Last Wednesday, Oct. 4, the Air Council gave a dinner at the Air Ministry in honour of the Hon. Eugene M. Zuckert, Secretary of the United States Air Force. Mr. Julian Amery, Secretary of State for Air, presided, and others present were Maj.-Gen. John H. Ives, U.S.A.F., Maj.-Gen. E. B. Broadhurst, U.S.A.F., Maj.-Gen. Glen L. Martin, U.S.A.F., Brig.-Gen. Grover C. Brown, U.S.A.F., Air Chief Marshal Sir Thomas G. Pike, Sir Maurice Dean, Air Chief Marshal Sir Edmund C. Hudleston, and Air Marshal Sir Kenneth B. B. Cross.

Argosy Trials.—An A. and A.E.E. Boscombe Down Argosy C.1 has recently completed a month's hot-weather and high-altitude trials in North and East Africa. At R.A.F. Eastleigh, Kenya, the transport was greeted on its first landing by Masai tribesmen. The first deliveries of Argosy C.1s to No. 38 Group, Transport Command, are expected at the end of this year.

R.N.A.S. Lossiemouth.—The Admiralty is planning to spend nearly £2.5 million on a general modernization scheme for R.N.A.S. Lossiemouth.

Own Fighter Support.—It appears likely that No. 38 Group, the Transport Command specialist tactical transport force, will have its own ground-attack fighters in the near future. These would be Hunter FGA.9s, probably from No. 54 Squadron (Sqn. Ldr. W. D. Dickinson) based at R.A.F. Stradishall.

No. 26 Squadron Reunion.—The annual reunion of No. 26 Squadron will be held in the Officers' Mess, R.A.F. Biggin Hill, on Friday, Nov. 10. Tickets, price 30s. each, and further details may be obtained from Flt. Lt. N. Bacon, Officers' Mess, R.A.F. Little Rissington, Glos.

No. 9 Squadron History.—A history of No. 9 Squadron is being written by Flg. Off. T. Mason, who, it will be remembered, was responsible for No. 12 Squadron's history—"Leads the Field"—published last year. Any readers who have information, photographs, etc., about No. 9 Squadron are requested to communicate with Flg. Off. Mason at the Officers' Mess, R.A.F. Finningley, Nr. Doncaster, Yorks. No. 9 Squadron was formed in 1914 and successively flew the Maurice Farman, B.E.2C, Vimy, Virginia, Heyford, Wellington, Lancaster, Lincoln and Canberra.

R.A.F. Concerts.—The 6th R.A.F. Anniversary Concert, held in London in April, resulted in £1,397 being raised for the R.A.F. Benevolent Fund. On Oct. 31 a special concert is being given in the presence of H.M. Queen Elizabeth the Queen Mother, to mark the 21st Anniversary of the Battle of Britain. Sir Adrian Boult will conduct the London Philharmonic Orchestra, which will be joined by the Central Band of the R.A.F.

MISSILE AND SATELLITE REVIEW

THIS special section of THE AEROPLANE AND ASTRONAUTICS is devoted to a broad review of the missile and aerospace scene. A three-page pull-out compares a wide range of satellites and space probes to scale; technical data are given on space vehicles launched since our last compilation appeared on Aug. 12, 1960. The article which begins on the next page is particularly relevant as tests are soon to begin in the Pacific with Nike-Zeus missiles.

There is also a feature outlining modern techniques of missile guidance and navigation. Missiles now in production and service are reviewed pictorially.

Symbolic of the marriage between missile and space technology, this splendid picture shows Atlas-D launching the Mercury MA-4 capsule on Sept. 13, 1961, which carried a crewman simulator once around the Earth.

ICBMs and Military Satellites —What Defence is Possible?

The ability to destroy ballistic missiles and spacecraft launched with hostile intent is an important aspect of strategic planning in the United States and, presumably, in the U.S.S.R. G. P. COATES, D.I.C., A.F.I.A.S., F.B.I.S., *examines some of the factors affecting the technical feasibility of establishing defence systems of this kind.*

THE destruction of an approaching ICBM or satellite poses some difficult problems and, apart from the difficulties of actually destroying this target or putting it out of action, a widespread and complicated system of early warning and tracking devices, computers, etc., is necessary to find and track it to the point of interception. In addition, the launching and guidance of the necessarily fast-moving interceptor vehicles present their own problems.

Although some of the problems associated with the destruction of ICBM warheads and satellites are basically similar, there are, nevertheless, others that are different. In either case, there would be little time in which to take defensive action and the system employed would have to be capable of locating the target at the earliest moment in order to give as much time as possible for any defensive action to be effective.

In the case of surprise attack, the defenders would be at a considerable disadvantage if their target were a satellite. Since it can reasonably be assumed that a nation would intentionally use ballistic missiles only for hostile purposes against another nation, any such missiles could be regarded as offensive weapons and defensive measures taken accordingly. Russian or American satellites, however, pass over most countries of the World every day and there would be little reason to suspect one satellite any more than another of being intended for a hostile purpose.

A hostile act on the part of a ballistic rocket or satellite need not, of course, consist of taking a nuclear warhead to its destination. Many other acts, such as the performance of reconnaissance missions could, while being less catastrophic at the time, have far-reaching effects. Here again a difference between the two types of target exists. The finite-range ballistic missile is restricted in the types of mission which it can reasonably accomplish and is likely to be used for the more dramatic types of operation; the satellite being better suited to the less direct forms of hostility, except in the surprise case already mentioned.

The destruction of an ICBM, or its warhead at least, presents a straightforward problem, albeit a difficult one; the satellite, however, presents the added difficulty of mission determination before the actual counter-measure can be used, and a good deal of effort is being directed toward the development of systems of satellite inspection for this purpose.

In any practical system the target vehicle would have to be destroyed, or rendered incapable of performing its intended task, by transporting the defensive device to, or near to, some intercept point along the trajectory of the target. This article, therefore, deals with defensive vehicles consisting of rockets, the payloads of which contain the defensive device.

Before taking a brief look at the type of vehicle necessary to deliver some form of countermeasure to the vicinity of its target, it will be instructive to investigate the possible forms which such countermeasures might take.

These can be broadly divided into two classes: the use of massive particles to cause impact damage; and the use of thermal and other radiation.

The height at which it is either desirable or necessary to intercept the kinds of target with which this article is concerned, sets the problem of destroying the target or some essential part of it in near-vacuum conditions. This means that the use of blast waves in any form is not possible, there being virtually no medium present in which such waves could propagate. The high speed of the target, however, means that destruction could be achieved by placing an object or objects in its path.

Two kinds of destruction method are usable in this way. The first is by the use of objects, the individual masses of which are sufficient to cause considerable damage on impact, e.g., pellets of metal or other hard material. The second is the use of larger numbers of smaller masses, the individual contributions of which are localized and the total effect being a rapid erosion. This latter method could be effective against a target carrying a bomb or other device which would be protected against heating and some erosion by a re-entry body—the effect being to produce a much intensified "re-entry" condition, with heating and erosion effects beyond the capabilities of the re-entry body. A hard material would be used for this and coarse particles based on, for example, silicon would be suitable. An extensive and dense cloud of coarse sand or quartz would cause severe erosion to satellite or missile warheads which are passing through it.

The material could be released into counter orbit if the target were a satellite, or ejected from a missile in such a way as to cause the target vehicle to encounter them.

For some satellite targets there is the possibility of using chemically active materials to corrode away the contents of the target vehicle, but the conditions of reaction would be difficult to create.

Nuclear Explosions

The use of electromagnetic and particle radiation forms perhaps a relatively more realistic means of destroying, or putting out of action, enemy satellites and missiles. In the case of the destructive methods already mentioned, there is latitude for error in time and position at interception in some cases only; when using radiation there is some latitude for interception error in both time and position in all cases, and, in most cases, the latitude is greater than in the case of the previous methods. An obvious source of radiation of the types mentioned is provided by a nuclear explosion of either fission or fusion types, and it should be possible to match the error latitudes to

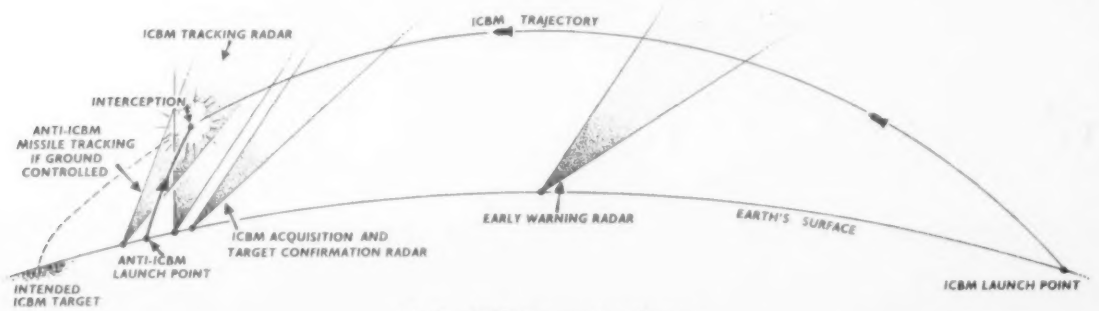


Fig. 1. ICBM interception diagram.

Missile and Satellite Review . . . .

present-day interception capabilities using nuclear explosions of only moderate yield.

Following a nuclear explosion in the atmosphere a considerable proportion of the total energy released is dissipated by the blast and shock waves formed. In space all this additional energy is radiated electromagnetically. This radiation could cause severe heating of the target, the amount in a given case depending on the reflective and emissive properties of the materials of which the target is constructed, as well as on the yield and "miss" distance. The heating of the target would be mainly direct, but partly due to the absorption of neutrons and other radiation. The principal effect of neutrons, gamma rays, etc., would result from their ionizing properties, and vital electronic components could be damaged by this, at least temporarily; and such damage could be sufficient to prevent essential sequences from being initiated and hence would amount, in some cases at least, to the target being rendered useless.

An estimate has shown that a nuclear explosion with a yield of 1½-2 megatons should be sufficient to destroy conventional satellite vehicles at distances up to about three miles, but temporary rearrangement of the properties of some electronic components would occur at about five times this distance. It should be possible to accommodate a warhead of the yield mentioned in a vehicle of 30,000-35,000 lb. launch weight.

The possible use of nuclear explosions for any purposes naturally raises the question of the secondary effects—particularly radioactive fall-out. The mechanism of fall-out from explosions outside the atmosphere is not fully understood, but it is known that air movements in the stratosphere play an important part in the distribution of the residue of an explosion. It would seem that the residence times of fall-out material in the stratosphere are much longer than in other regions of the atmosphere and—since in a nuclear burst the proportional production of isotopes favours the short half-life and, therefore, high activity kinds—it is possible that most of the dangerous ones would decay before reaching the surface. However, other dangerous isotopes, such as Strontium-90 and Caesium-137, with approximate half-lives of 28 years and 30 years respectively, would presumably remain in the stratospheric reservoir to descend over long periods of time.

Any arguments about fall-out from the types of nuclear explosion resulting from the use of defensive weapons are, in any case, probably academic. In the circumstances in which these weapons would be used it is likely that much more serious fall-out and other hazards would have to be faced. At best it would be a choice between 2 megaton yields 200 miles or so above the surface or bursts of 10 megatons or more at or near the surface.

In some special cases it might be possible to use countermeasures other than of the two main types mentioned.

In view of the relatively short time available between the identification of a hostile vehicle and its arrival at its target, or at a point from which the hostile act would be initiated, defensive missile systems must possess certain features not necessarily found in systems for other applications. The time available from an early warning system would, in practice, be not more than 15 to 20 minutes for a missile travelling to a target about 5,000 miles from its launch point. In the case of a satellite, the time available for action could, in some cases, be longer; but in other cases the time would be only about the same or less, as the discrimination process after initial acquisition may well take longer than is the case with ballistic missiles.

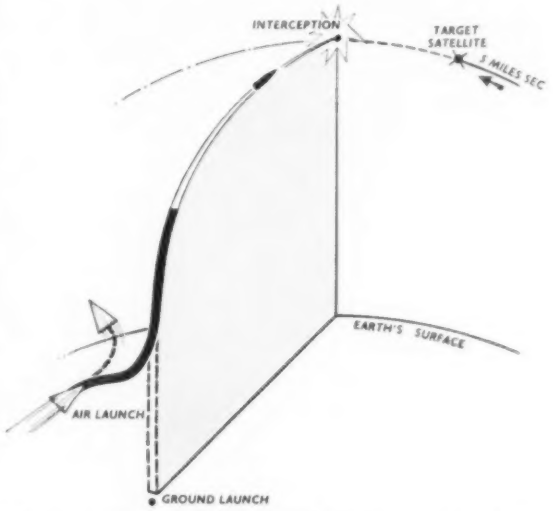


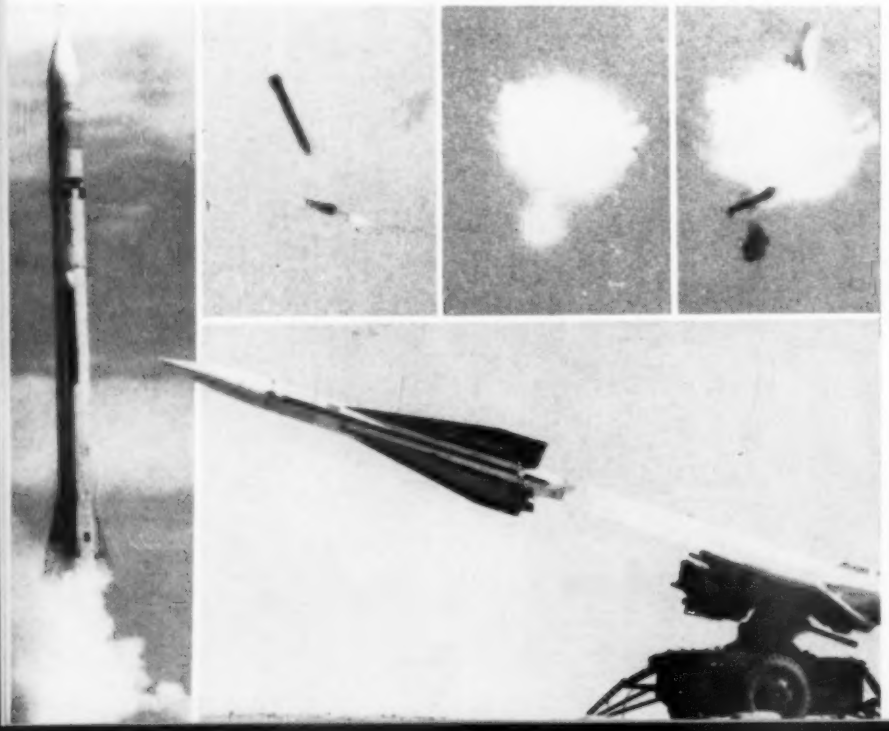
Fig. 2. Interception of a satellite by air- or ground-launched missile.

Acquisition and Tracking

The tracking and computer facilities associated with defence weapons are likely to be complex and to feature more prominently in the defence system as a whole than in most other missile systems. Fig. 1 shows diagrammatically a possible scheme for the target acquisition and tracking facilities for anti-ICBM missiles. The early warning radar would detect and track the target missile and an associated computer would process the tracking data and send information about intended target location to the local radar, which would be situated near the defence-missile launch sites selected to defend the intended ground target. The local radar would "receive" the target warheads and pass them on to selected tracking radars, which would confirm the intended target and track the warheads; associated computers would determine the intercept point and pass the information to the defence-missile guidance system. The defence-missile guidance computers would then determine the trajectory of the defence weapon and the latter would proceed on this course, corrections being applied based on information received from the target-tracking radar.

If the defence missile is ground-controlled, it would be tracked by yet another radar.

Missiles for this form of defence would use solid propellent rockets since the time taken to prepare even a relatively small liquid propellent rocket is still too long for them to be of much use in defence against ICBMs and satellites. Storable liquid propellents could be used, but the solid propellent rockets should be more suitable since they are relatively simple as well as having a very short readiness time.



These pictures show the result of an engagement above White Sands on Jan. 23, 1961, in which a Hawk surface-to-air missile, with H.E. warhead, was used to destroy a Corporal ballistic missile. Hawk is normally employed for aircraft defence up to altitudes of 60,000 ft.; it uses semi-active homing, responding to target reflections from continuous-wave ground radar.

An early version of the Western - Electric/ Douglas Nike Zeus being prepared for launching at White Sands in February. Its Thiokol booster has a sea level thrust of 450,000 lb. The Grand Central sustainer, with lightweight case, plastic nozzle, and high specific impulse solid propellent, develops about 350,000 lb. s.t. Overall length, 63 ft.; body diameter, 60 in.

The requirement for a defence missile of the type being discussed could be met by using a payload delivered to the proximity of its target by a two-stage rocket consisting of a very high thrust booster burning for perhaps five seconds with an initial thrust approaching 10 times the launch weight; and a second-stage sustainer with a much lower thrust in relation to the accelerated mass, and burning for a longer period. A payload, carrying small reaction jets and some fuel for fine adjustment at rendezvous, could increase the effectiveness of the system.

Since the missiles are characterized by short flight times and, therefore, high acceleration during the thrusting period, the loads experienced by this type of vehicle will necessarily be high. The structure weight of the vehicle will be relatively high in order to cater for the loads due to the high accelerations resulting from high thrust and manœuvres for trajectory correction. Powerful aerodynamic controls are likely to be required to provide these manœuvres, at least during the boost phase. In addition to imposing stringent requirements on the vehicle itself, the equipment contained by the vehicle must be rugged in order to provide reasonable reliability—an important consideration in a vehicle for such a purpose.

In addition to the direct loads, the high speeds at relatively low altitudes cause large aerodynamic forces and heating effects. The forces are proportional to the dynamic pressure, which in turn is contributed to by the air density and the velocity. The increase of speed and decrease of density after launch causes the dynamic pressure to increase to a maximum and then decrease again. The magnitude of the maximum and the height at which it occurs clearly depend upon the acceleration of the vehicle and the height from which it is launched.

This latter point raises the question of the feasibility of launching anti-ICBM and anti-satellite vehicles from aircraft, in order to reduce the excessive penalties caused by aerodynamic loads. While the direct advantages of initial launch speed and altitude on the final velocity and height at interception may be fairly small (launch from suitable aircraft at present may be at about 800-900 ft./sec. from perhaps 10 miles high, but interception would probably be at a height of about 200 miles in either case with the defence missiles travelling at about 15,000 ft./sec.) the launch height quoted could produce a tenfold reduction of dynamic pressure for similarly accelerated vehicles. While aerodynamic forces provide a very useful and perhaps necessary supplement for vehicle control during the boost phase, the dynamic pressures encountered by the rapidly accelerating vehicles are greatly in excess of those required for even the most powerful control cases using acceptable control geometries and the air launch conditions mentioned.

Air launch would also have the advantage that warning of an attack could result in aircraft which are carrying these defensive, as well as those carrying retaliatory offensive weapons, being off the ground and out of a target area before the attack was actually delivered. While surface launch sites for defensive weapons may be destroyed by the attack, aircraft flying a hundred or so miles from such a target would be much less vulnerable. Such aircraft could remain in the air for many hours while still providing "local" defence for a target. Fig. 2 shows the types of path a missile might take in attacking a satellite in orbit. Ground launched and air launched paths are shown.

As in the case of the anti-ICBM missile, the path will be a steep one. Apart from the time factor involved, there are benefits in this in terms of payload for a given launch weight. The intercept point may be beyond the apex of the trajectory.

Although the trajectory is shown in a plane normal to the orbital plane of the target satellite, it could be anywhere between this direction and head-on to the target.

While an air-launched anti-missile or satellite missile has not so far been demonstrated, as long ago as Oct., 1959, the U.S.A.F. launched a ballistic missile from a B-47 bomber to pass within four miles of their Explorer VI satellite when the latter was close to perigee. This shot was, in fact, in connection with the present "Skybolt" programme and not claimed to be associated with any anti-satellite weapon programme. A dummy warhead was fitted to the vehicle.

Nike Zeus Tests

The only anti-ICBM missile programme of which any details have been published is the United States Army's Nike Zeus. This is a system designed for the defence of targets against ICBM attack and is the system for which the early warning radar chain at Clear (Alaska), Thule (Greenland) and Fylingdales Moor (England), is being erected. The first two stations are already working and the chain is designed to detect any ballistic missile leaving the U.S.S.R. for a target in the United States.

The Nike Zeus missiles are two-stage vehicles of the boost and sustainer type and are ground controlled. The warhead is nuclear and of undisclosed yield. The missiles have a range of about 200 miles.

The system is reported to be nearing the stage when a live warhead firing could be made and the test programme includes such a firing at an Atlas missile. The recent unilateral resumption of nuclear tests by the Russians means that this important step in the Nike Zeus development programme will probably be carried out. A missile of this type, with a dummy warhead, was recently fired successfully by the U.S. Army and earlier versions have destroyed missiles in flight. The early warning and tracking system for Nike Zeus is similar to that shown diagrammatically in Fig. 1.

In conclusion, it could be stated that, technologically, the development of a system of defence against ballistic missiles and satellites is feasible. The problems involved, however, would be numerous and difficult, and the cost enormous. The reliability of such a system would have to be high in order to make the system effective. Decoys could be used by the nation launching the attack and the majority of an arsenal of defensive weapons could be wasted on dummy warheads interspersed with active ones in an initial onslaught.

A nation attempting to defend itself against such an onslaught would probably at most reduce the weight of a crushing blow and it may save the lives, temporarily, of some of its population. There would be little chance that it would alter the cause of events.

Perhaps the best way of keeping a nation's finger off the "button" is to make sure that it is aware that pressing it would inexorably lead to its own annihilation.

Nike Zeus in its first full-scale test of "missile, guidance and related systems" at Pt. Mugu, Calif., on Sept. 9. The second stage exploded some four seconds after leaving the booster.

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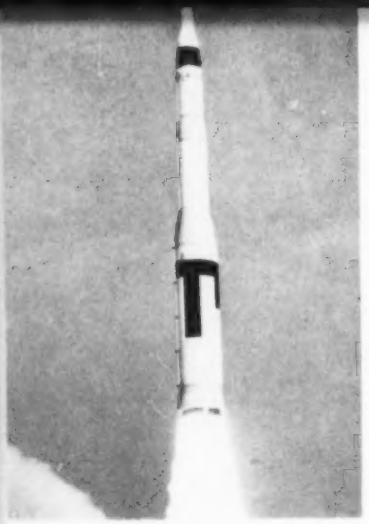
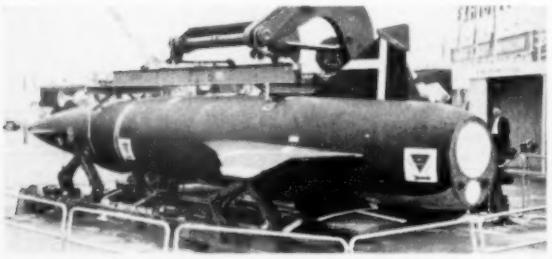
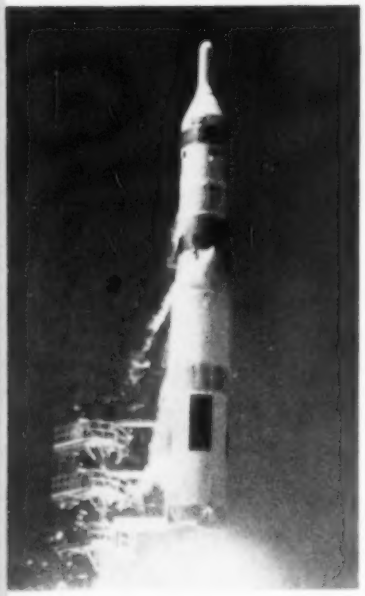
World Missile



Boeing SM-80 Minuteman (left).—Second-generation three-stage solid-propellent ICBM for mobile or underground launching. The first U.S.A.F. 50-missile hardened launch complex at Malmstrom A.F.B. due in service in mid-1962. Inertial guidance; launch weight 65,000 lb.; range 6,000 miles, plus; burnout Mach No. 22; estimated warhead yield 2 megatons.

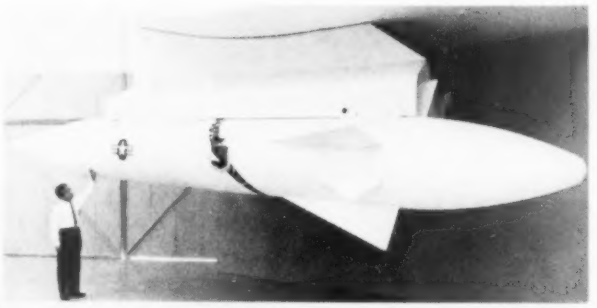


Avro Blue Steel Mk. 1 (above).—Liquid-propellent stand-off bomb in production for R.A.F. Bomber Command. Victor B.2s and Vulcan B.2s, each carrying one missile beneath the fuselage. Improved Mk. 1* version with greater range under development. Inertial guided; estimated launch weight 15,000 lb.; range 150 miles; maximum Mach No. 1.6; estimated nuclear warhead yield 4 megatons.



Martin SM-68 Titan (left).—Initial production version of this two-stage liquid-propellent nuclear ICBM is expected to be fully operational this year. U.S.A.F. now plan six squadrons, each with 10 missiles in underground silos, at five bases. Titan 1s have radio-inertial guidance; launch weight 220,000 lb.; range 7,000 miles; burnout Mach No. 26; estimated warhead yield 4 megatons.

North American GAM-77A Hound Dog (above).—Carried by B–52Gs, this turbojet stand-off bomb has been operational with U.S.A.F. since December, 1959. First S.A.C. launch of production missile in March, 1960. Stellar-inertial guidance; launch weight 10,000 lb.; range 400–600 miles; cruising Mach No. 1.6; nuclear warhead yield 4 megatons.



Douglas GAM-87A Skybolt (above).—Two-stage solid-propellent air-launched ballistic missile, scheduled to be operational with S.A.C. and Bomber Command in 1964. B–52Hs will carry four Skybolts and Vulcan B.2s two. Developed stellar-monitored inertial guidance system; launch weight 9,000 lb.; range 1,000 miles; Mach No. 9; nuclear warhead yield 2 megatons.

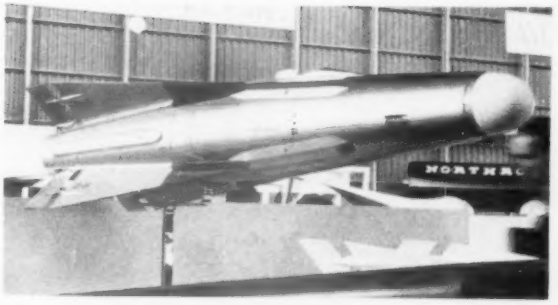
Lockheed A1-P Polaris (left).—U.S.N. submarine-launched two-stage solid-propellent ballistic missile with nuclear warhead. Five submarines with 16 missiles each now in operational service. Inertial guided; launch weight 28,000 lb.; range 1,200 miles; burnout Mach No. 10; estimated warhead yield 0.5 megatons.

McDonnell GAM-72A Quail (above).—Bomber diversionary and electronic countermeasures turbojet missile dropped from B–52s and B–47s. Recently became operational with S.A.C. Weight 1,100 lb.; range 200 miles; Mach No. 0.9.

Western Electric Nike Zeus (left).—Two-stage solid-propellent anti-ICBM surface-to-air missile for U.S. Army. First test firings completed. Radar command guidance; estimated launch weight 40,000 lb.; range over 200 miles; Mach No. 4, plus; nuclear warhead.

Digest

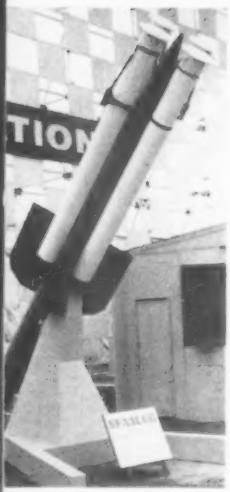
Some of the foremost missiles chosen by the World's armed forces, comprising SSMs, SAMs, AAMs, and ASMs. Leading data are included.



Hughes SAR-11 Falcon (above).—Developed solid-propellent Falcon AAM with nuclear warhead and more power. Now in service with U.S.A.F. North American Air Defence Command F-102 squadrons. Semi-active homing guidance; launch weight over 200 lb.; range more than 5 miles; Mach No. 2.5, plus; estimated warhead yield 2 kilotons.

Bristol/Ferranti Bloodhound Mk.1 (left).—Surface-to-air Ramjet/solid-propellent missile in service with R.A.F. Ordered by Sweden, Switzerland and Australia. Improved Mk. 2 version provides better target discrimination at low angles of elevation, and greater security from counter-measures. Semi-active homing; range 60 miles, plus.

English Electric Thunderbird Mk. 1 (left).—Solid-propellent mobile SAM system in operational service with the British Army. Improved Mk. 2 versions with increased range and better low-altitude performance in advanced development state. Semi-active guidance in conjunction with target tracking and illuminating radar; range 20 miles, plus.



Soviet Type M-2 (above).—Surface-to-air missile basically similar to U.S. Nike-Ajax. Tandem-boost by single solid-propellent motor. Probably beam-rider guidance; estimated launch weight 1,500 lb. (without booster); range 20 miles; burnout Mach No. 2.5; H.E. warhead. Stated to have brought down U-2 reconnaissance aircraft.

Armstrong Whitworth Seaslug Mk. 1 (left).—Medium-range solid-propellent anti-aircraft missile in production to arm Royal Navy's County class destroyers. Fired from twin launchers. Seaslug Mk. 2 under development. Beam-riding guidance; warhead initially H.E.

Short Seacat (above).—Standard two-stage solid-propellent short-range anti-aircraft weapon for R.N., to arm "Daring" and County class destroyers. Also ordered by Sweden and Germany for evaluation and selected for R.A.N. and R.N.Z.N. Developed Seacat Mk. 2 also employing a two-stage motor has supersonic performance and greater range. Radio command guidance; estimated maximum altitude 10,000 ft.

g IM-99B Super Bo- (right).—Advanced of the U.S.A.F. ramjet/ propellent IM-99A area e intercepter missile. command-active homing ce; estimated launch t 15,000 lb.; range 500 ; maximum altitude),000 ft.; Mach No. 4.

Convair Advanced Terrier (right).—Ship and mobile ground launched two-stage solid-propellent SAM in service with U.S. Navy and Marines. Reported beam-riding and terminal homing guidance; launch weight 5,000 lb.; maximum range 20 miles, plus; Mach No. 3.

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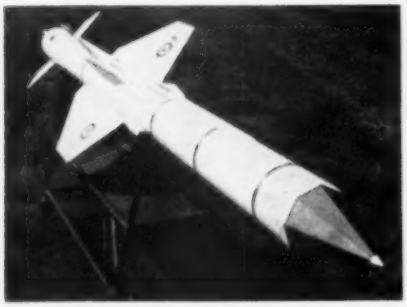
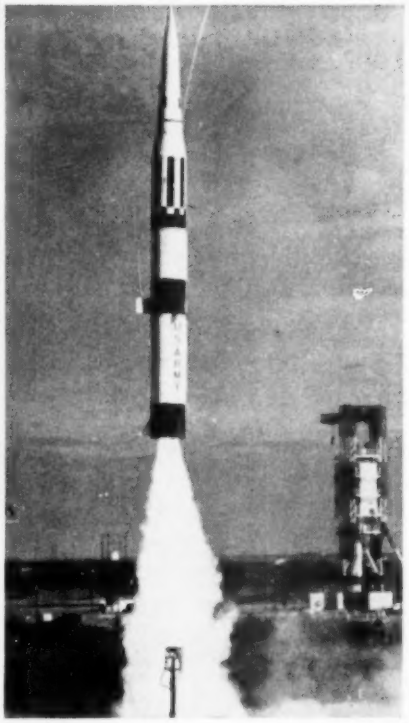
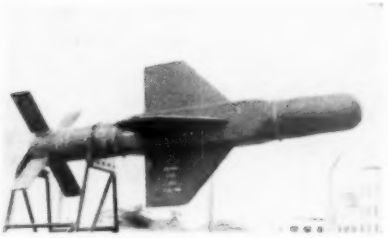
Raytheon AAM-N-6 Sparrow III (above).—All-weather liquid or solid propellent AAM operation with U.S. Navy F3H and F4H squadrons. Capable of collision-course interception. Semi-active homing guidance; weight 350 lb., range over 5 miles; Mach No. 2.5; H.E. warhead.



de Havilland Red Top (above).—A solid-propellent AAM similar to Firestreak but with developed infra-red heat-seeker. Operationally, it is said to improve markedly on the lead-pursuit-course capability of its predecessor. Infra-red homing; estimated maximum range 8 miles; mach No. 3, plus; 68-lb. H.E. warhead.



Martin Pershing (above).—Selective combat-range artillery missile (SCRAM) to replace Redstone in U.S. Army. Due in service this year, it is a highly mobile two-stage solid-propellent weapon with a nuclear warhead. Inertial guided; launch weight 10,000 lb.; range 300 miles, plus; speed 3,000 m.p.h., plus; approximate warhead yield 20 kilotons.



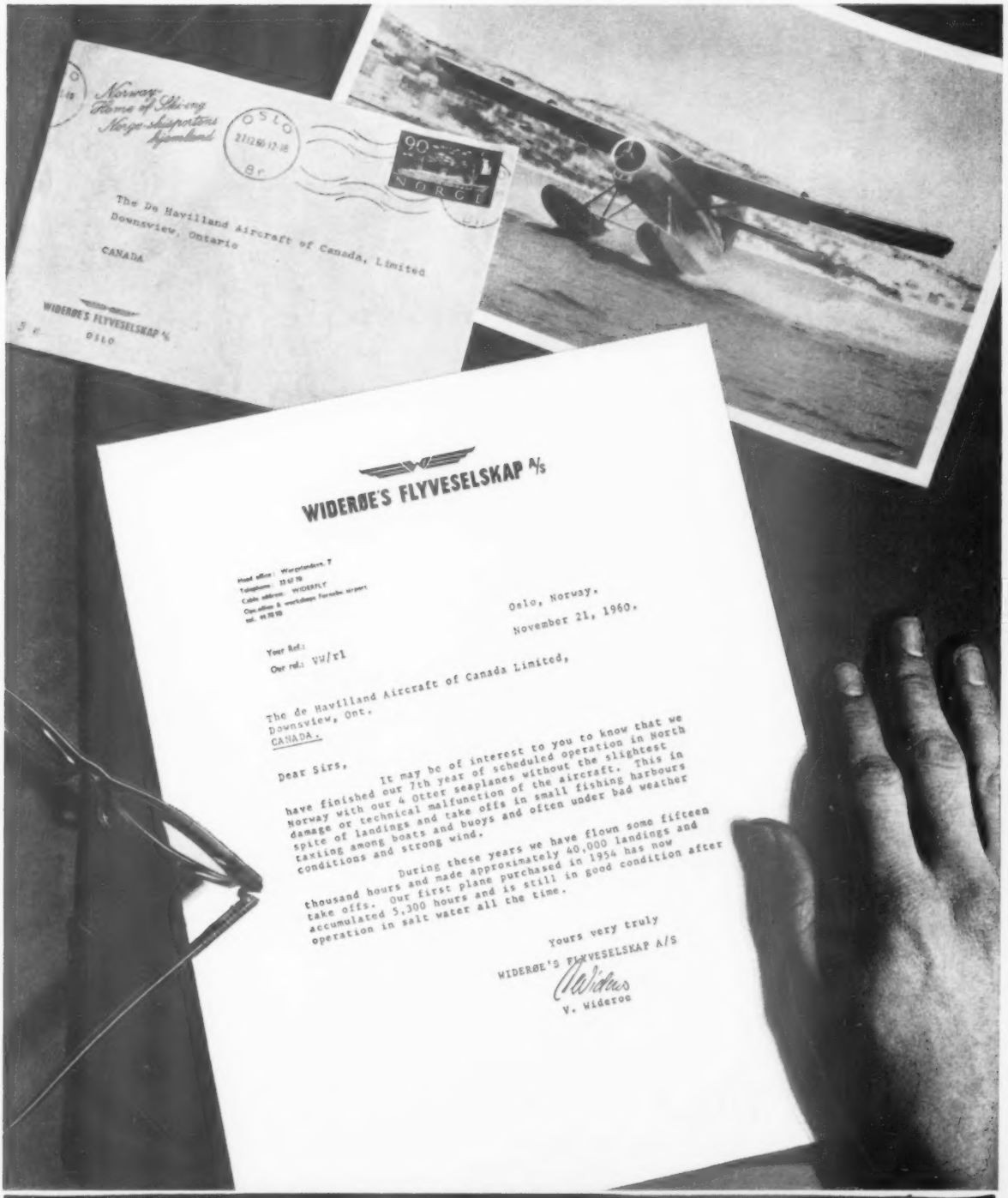
G.A.F. Malkara (above).—Australian two-stage solid-propellent anti-tank missile—400 of which have been ordered for the British Army. Fairey Engineering hold World-wide (except U.S.A.) sales agency. Wire guided; launch weight 206 lb.; range 2 miles; speed 400 m.p.h.; large H.E. warhead.

Vickers Vigilant (below).—One-man two-stage solid-propellent anti-tank missile. Ordered by British Army for assessment trials. Wire guided; launch weight 31 lb.; range 1 mile; speed 350 m.p.h.; 6-lb. H.E. warhead.

Soviet Type T-5C (above).—Surface-to-surface tactical missile, similar to solid-propellent U.S. Honest John. Transporter/launcher derived from Type 1955 (JS.3) amphibious reconnaissance ASV chassis; aimed, spin-stabilized, unguided. Estimated launch weight 4,400 lb.; range 10–15 miles, warhead probably H.E. or nuclear.

Soviet "Probeda" (Victory) (above).—U.S. designation T-1 (M-101), SSM tactical, developed from German V-2. In production 1949–50; first Rocket Divisions equipped 1950–51. Inertial or radio-inertial guidance; estimated launch weight 45,000 lb., plus; range 560 miles; burnout Mach No. about 6.5; H.E. warhead. Later variant probably has H.E. or nuclear warhead.

English Electric Blue Water (left).—Highly optimized mobile tactical two-stage solid-propellent SSM being developed for British Army. Missile system comprises Land-Rover transported computer and missile launcher/transporter mounted on a 3-ton lorry. Inertial guided; range 70 miles, plus; H.E. or nuclear warhead.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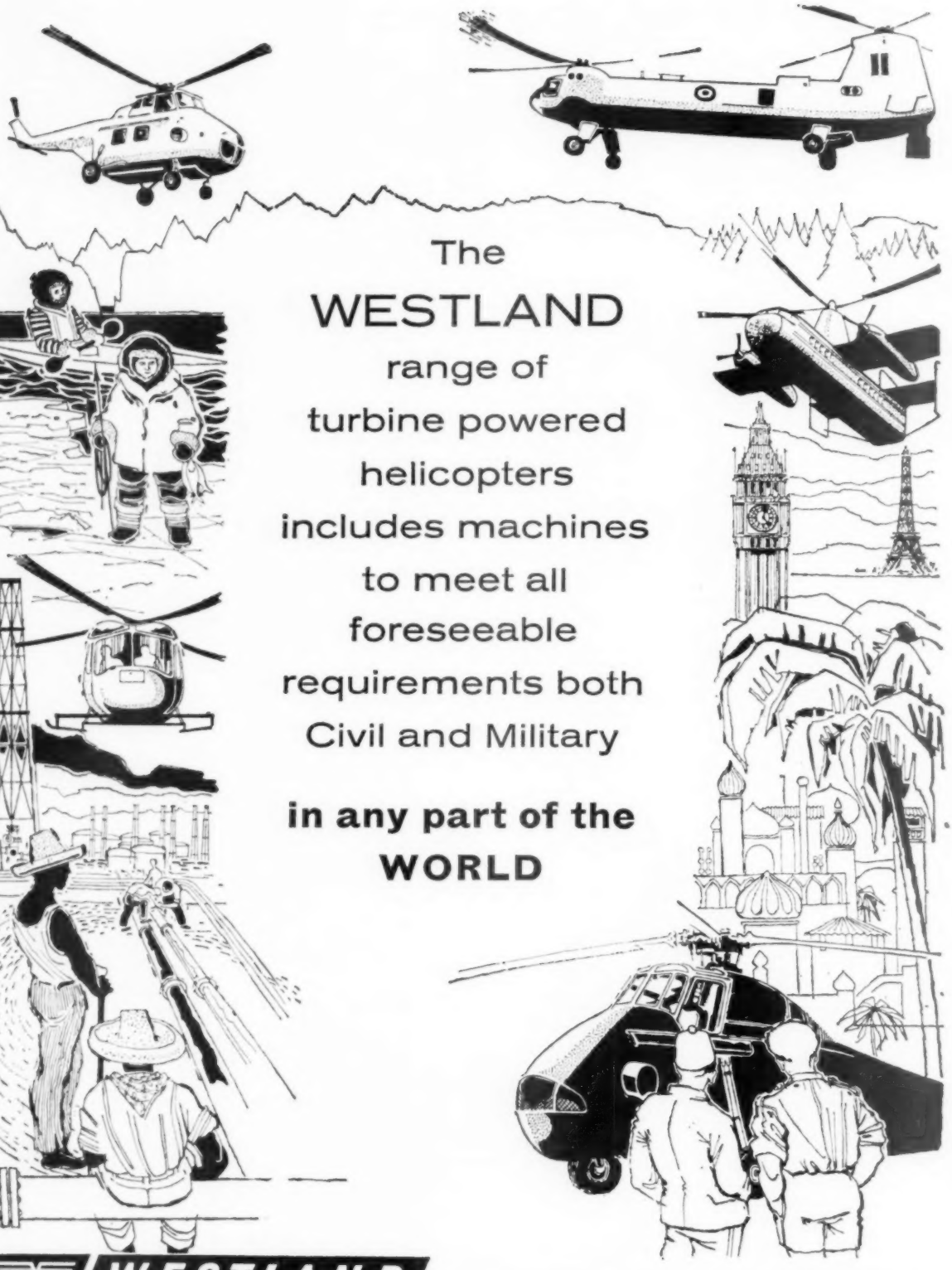

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Missile and Satellite Review . . . .

Navigating the Missile

In this article "NAVIGUS" reviews in simple terms the essential requirements for missile guidance systems and outlines the basic methods adopted. The author summarizes the leading characteristics of the various missiles.

LONG-RANGE surface-to-surface and air-to-surface missiles travel into areas where the enemy has radio supremacy. Furthermore, in their rôle as ultimate deterrents, they have to be impervious to interference. Hence nearly all use inertial navigation, although the early LRBMs used mixed radio and inertial navigation systems.

Inertial navigation was described in the Guided Missile number of THE AEROPLANE AND ASTRONAUTICS published on May 27, 1960. It was emphasized that the accelerometers, which measure accelerations, and the gyroscopes, which maintain the directions in which those accelerations are measured, are the keys to performance. It was also explained how the errors of these instruments were modified by the self-correcting effect of gravity; gravity limits the accelerometer error but only modifies the gyroscope error (Fig. 1).

A ballistic missile is guided during the first few minutes of its flight by inertial navigation. The motors then burn out and, since the missile ceases to accelerate, its accelerometers can collect no more information.

It is evident that over a few minutes of time gyroscope errors are very small; indeed, over five minutes they are of one-eighth of the error over 10 minutes. The accelerometers are, therefore, the key components. However, if we can believe the claims made for accuracy, the necessary standard of performance is being achieved.

TABLE 1
TYPES OF BALLISTIC MISSILE SYSTEM AND INSTRUMENTS

	Systems in service	Systems under development	Projected systems
Weight	700 lb.	150 lb.	70 lb.
Pure inertial	80%	100%	100%
Radio command and inertial	20%	—	—
Single-axis gyros	70%	100%	70%
Two-axis gyros	30%	—	30%
Liquid-floated gyros	70%	100%	70%
Gyros supported but not by liquid	30%	—	30%
Force feedback accelerometer	—	40%	100%
Integrating gyro accelerometer	100%	60%	—
Analogue computer or analogue-digital	60%	40%	100%
Digital computer	40%	60%	100%
Accuracy (estimated) as percentage of range	0.1%	0.05%	0.02%

The summary in Table 1 suggests a revival in popularity of the two-axis gyro, in spite of the difficulties in balancing, and of the force feedback accelerometer, which demands extremely precise manufacture if it is to achieve the required accuracy. These two trends are the results of the need to reduce the weight of gyros and accelerometers, which are the keys to the size of inertial navigation systems as well as the keys to performance.

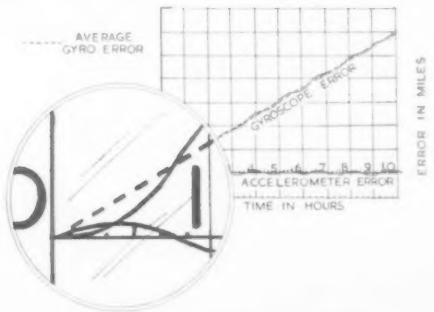

Fig. 1. Comparison of gyroscope and accelerometer errors.

Inertial Navigation for Non-ballistic Missiles

The stand-off bomb would seem to have a flight time of about 20 min. The requirement, as compared with the ballistic missile, is to guide the bomb all the way to the target lest winds blow it off course, but Fig. 1 suggests that this will not make unreasonable demands on the gyroscopes.

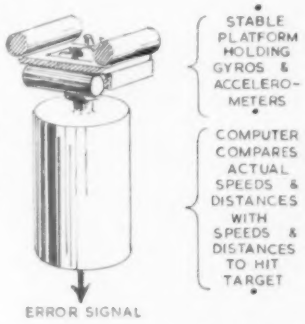
STABLE PLATFORM HOLDING GYROS & ACCELERO-METERS
COMPUTER COMPARES ACTUAL SPEEDS & DISTANCES WITH SPEEDS & DISTANCES TO HIT TARGET
ERROR SIGNAL

Fig. 2. Typical inertial system used in ballistic missiles; the table is mounted outside the gimbals for ease of access.

It can be arranged that, at the end of the flight, the bomb noses down on to its target. The guidance system, therefore, has only to measure position on the surface of the Earth; thus only two accelerometers are needed. One of these can measure accelerations along the line to the target, which can be integrated twice to obtain the correct range. The other accelerometer can measure accelerations across the track which can be integrated twice and used to steer the missile along the correct line to the target (Fig. 2).

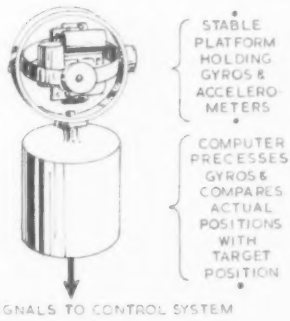
STABLE PLATFORM HOLDING GYROS & ACCELERO-METERS
COMPUTER PRECESSES GYROS & COMPARES ACTUAL POSITIONS WITH TARGET POSITION
SIGNALS TO CONTROL SYSTEM

Fig. 3. Inertial navigation system in which the gyroscopes are precessed to stabilize the platform.

For every mile travelled along the track to the target or for every mile the missile deviates sideways off this track, the surface of the Earth will curve away by one minute of arc. This change in the direction of the pull of gravity will evidently affect the accelerometers. The platform holding the accelerometers will accordingly have to tilt by a minute of arc for each mile that the missile covers. The tilting of the platform is achieved by making the gyroscopes that stabilize it precess.

The system is illustrated diagrammatically in Fig. 3. As the missile may need to make considerable manœuvres, the gimbals have been shown mounted outside the platform. As regards the critical components, from information so far released in America it would seem that stand-off bomb systems generally

Missile and Satellite Review . . . .

use single-axis liquid-floated gyroscopes and force feedback accelerometers, the latter being acceptable since the gyroscopes are the more critical components.

Long-range Pilotless Bomber

The strategic long-range pilotless bomber has a duration of up to 10 hr. Over such a period the gyroscope errors will be very serious and it will be necessary to find a way to correct gyro drifts.

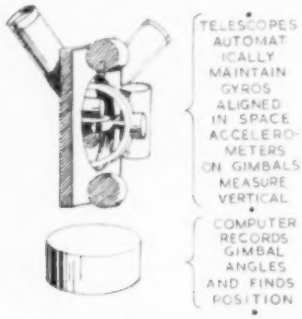
TELESCOPES AUTOMATICALLY MAINTAIN GYROS ALIGNED IN SPACE
ACCELEROMETERS ON GIMBALS MEASURE VERTICAL
COMPUTER RECORDS GIMBAL ANGLES AND FINDS POSITION

Fig. 4. Auto-astro. For simplicity the gimbals holding main stable platform are not shown.

The type of system is illustrated in Fig. 4 but, to save complication, the gimbals holding the main platform have been omitted. On this platform are shown two telescopes which can be locked automatically on to two stars. If the gyros drift, the platform will tilt and the telescopes will become misaligned. By feeding these misalignments back into the gyros to precess them, the platform can be kept continually lined up with the stars and the gyroscopes continuously corrected.

Such a system really involves carrying the sky about inside the aircraft and using the accelerometers to measure the direction of the vertical. Indeed, it relies so fundamentally for its accuracy on the sky that it is often known as "auto-astro."

Auto-astro systems, according to information released to date by the United States, tend to use single-axis floated gyroscopes and force feedback accelerometers. The systems are somewhat bulky owing to the large platform requirements and, indeed, the weight of a typical auto-astro guidance system has been assessed as the best part of half a ton.

TABLE 2

APPLICATIONS OF INERTIAL NAVIGATION SYSTEMS

Class of missile	Description	Range (n.m.)	Period of guidance (hr.)	Percentage using various inertial navigation systems			
				Inertial		Auto-astro	Precessed
				True	Radio		
Strategic SSM	ICBM—Very long-range ballistic	5,500	0.1	60	40	—	—
	LRBM—Long-range ballistic	2,000	3.3	80	20	—	—
	Pilotless long-range bomber	1,500	10.0	—	—	70	—
Tactical SSM	MRBM—Medium-range ballistic	150	0.05	80	—	—	—
Strategic ASM	Stand-off bomb medium range	300	0.3	—	20	—	60

Visual Guidance

Inertial navigation is the system used to guide the longest-range SSM and the human eye is the system used to guide the shortest-range SSM "field of battle" weapon. The human eye is not only amazingly selective but also extraordinarily accurate—more accurate than any other form of guidance.

Although the eye is so precise, the human brain takes an appreciable time to translate the information received by the optic nerve into action. The normal reaction time required is about a quarter of a second, even with a highly trained individual.

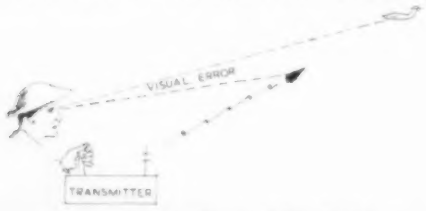

Fig. 5. Visual guidance with radio link.

For this reason, the missile guided by the human eye will normally have rate gyroscopes or some similar stabilizing system to keep it steady during the hiatus caused by human reaction time. It will also need a roll gyro since the human eye may not be able to see exactly which way up it is flying at a distance.

The information from the human eye is generally translated into action by means of a joystick. Originally, fairly large control columns were used but today the preference is for small, thumb-operated joysticks.

Movement of a joystick can be connected to what the human eye sees in a number of ways. For example, it could be arranged so that the missile would shift sideways by an amount equal to the sideways push on the joystick. Unfortunately, distance off may not be a useful guide. It will be much better if the joystick is made to correct the closing speed rather than the displacement.

Having translated the information from the human eye into movements of the thumb joystick, the next requirement is to carry the instructions to the missile itself. In short-range weapons launched from the ground, the signals can be carried along wires. These wires are mounted on bobbins within the missile so that the missile trails them behind; in such an arrangement the missile has to carry the weight of the wire, but there are many good reasons for adopting this system.

If the missile were to have to drag the wire out of a bobbin on the ground, the wire would be moving forward through the air with the missile and the air resistance would be appreciable. Even more serious would be the need to drag the wire across the ground, for after the missile had travelled a short distance the wire would inevitably sag, catch on something and break. Hence the wire is made to peel out from the missile body, or from bobbins on the wings, so that it falls and lies quietly on the ground.

The original wires used by missiles were enamelled steel, generally two or three strands. Latest techniques use cables that can carry a number of messages simultaneously. The mile or so of cable may only weigh 2-3 lb., and even the most rudimentary radio receiver could hardly weigh much less. However, the great advantage that wire carrying has over radio carrying is that it is impossible to upset the signals except by cutting the wire. Furthermore, the problems of mutual interference inherent in radio control are eliminated.

Even for field-of-battle surface-to-surface missiles, wire guidance is only used for ranges of the order of a mile or so. The longer the range, the longer and thicker the wire needs to be. If the wire has to string out a couple of miles, the weight involved in carrying the spool will become much greater than the weight involved in carrying a simple radio receiver. Hence, for longer-range missiles, although the human eye may still be used for guidance and the human hand on the joystick or on the control column may still direct the missile, the information will be carried not by a wire but by a radio link (Fig. 5). Although this involves a radio transmitter and receiver, the essence of guidance will be the human eye. The information that it receives is translated into an error signal through the human brain and the human hand. It is, therefore, reasonable to refer to such systems as visual guidance, even though the wire link has been replaced by a radio link.

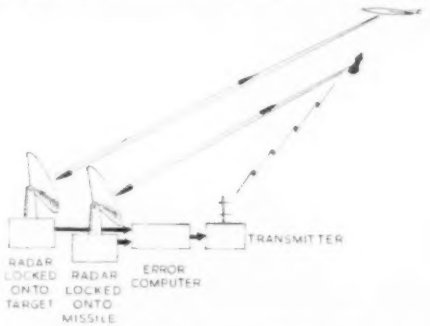

Fig. 6. Radio command system.

Radio Command Systems

Visual guidance is most suited to battle conditions because it can use human judgment and discrimination and can distinguish friend from foe. However, visual guidance can be nullified by fog and, even in clear weather, tends to be less effective as the range increases. For the "short-range" missile, with a carry measured in tens of miles, radio guidance will be preferred. Fig. 6 shows the arrangement, which is

(Continued on page 491)

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(*Continued from page 490*)

similar to that of visual guidance, except that one radar eye watches the missile while another radar eye watches the target.

A target such as an aircraft can easily be "seen" by radar against the background of the sky. However, a target on the ground is less easily distinguished unless it is moving or is particularly distinctive like a ship at sea. Therefore, the radar that watches the target may have to be replaced by some other information, such as a knowledge of how far away the target is and in which direction. By this means radio command may be used to guide a short-range SSM. It may even be possible, by passing the command on from one point to another, to use radio command for a medium-range missile, the guidance culminating in a final visual run on to the target.

The radar eye generally consists of a gimbal-mounted reflector, or dish, with an aerial system mounted at the focus. This aerial system may consist of four separate aerials, so that signals can be detected as coming more from the left or the right, or more from above or below. Alternatively, the aerial may spin so that the direction from which the signals are coming may be detected. Whichever system is used, the error in direction recorded by the aerials will be fed back into motors that drive the gimbals and these will swivel the dish until it is looking directly at the target once more.

It is easy to arrange that the radar watching the missile starts by pointing along the line of launch so that it will "see" the missile immediately after launch and be able to follow it thereafter. In the case of the target-watching radar, however, information will be needed to enable the dish to know which way to "look" initially. This will be provided by a "warning" radar with a wide angle of coverage which detects targets and passes the necessary information to the tracking radar of the "radio command" system.

In addition to measuring direction, a radar system can also measure range. A device inside the radar receiver, known as a "gate," is made to follow the target in range just as the dish follows it in direction. This gate can be made to exclude echoes coming from targets at other ranges. This will generally prevent the radar eye from wandering off if something else appears along the line of sight—because this will normally be at a different range and so will be excluded by the gate.

Having measured the range and distance to the missile and the range and distance to the target, the two can be compared in an electronic computer and the path that the missile ought to follow to intercept the target may be calculated. This guidance information is then passed to the missile through a radio link.

The radio command system obviously allows for a very simple missile, and this is important because the missile is expendable. However, it does demand complex ground equipment. Furthermore, it uses a number of transmitters any one of which could be subjected to interference. This makes it much less suitable for the crowded conditions of the battlefield than other systems.

Radio command systems may also be favoured by short-range surface-to-air weapons, but not generally by short-range air-to-air missiles. It is a complex enough problem for a computer to solve when both the target and the missile are moving but, when the launcher is also moving, the problem of computing the amount of turn needed for an interception is vastly more difficult. Hence, radio command systems are generally confined to aiming from aircraft at fixed targets or aiming from the ground at either fixed or moving targets.

Beam Riding

In certain small short-range air-to-air weapons the line of sight to the target can be established by pointing the fighter aircraft at the enemy. A radio beam pointing dead ahead from the fighter will, therefore, provide a line to the target and the missile can be made to fly along this beam (Fig. 7).

However, for longer ranges and for surface-to-air weapons, the radio beam will probably be established by a radar system as shown in Fig. 8. It will be noted that there are two beams rather than one. When the missile is first launched it tends to wander a little from its path, partly because it is not travelling fast enough for the controls to be fully effective. Furthermore, if it is fitted with wrap-round boosts for mobility, as is Seaslug, these may not burn absolutely evenly. Therefore, in addition to the fine pencil beam for steering the missile to the target, there is a coarse "gathering" beam which will shepherd the missile into the pencil beam after its initial wanderings.

It is a common misconception that a beam rider is a very

Fig. 7. Air-to-air beam-rider.

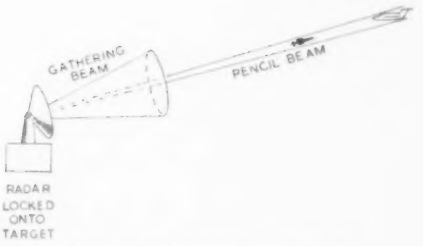

Fig. 8. Surface-to-air beam-rider.

simple missile. However, the beam has to indicate not only in which direction is the exact line of sight, but also how far off this line of sight the missile is flying.

The beam, therefore, is complex. Like the arrangement of the aerials in the radar dish, it has either to be in two parts which can tell the missile how far it is off its line left or right and up or down; or, alternatively, it may be of the circular type that tells the missile how far off it is and in which direction.

The missile receiver has to be able to deal with this information and, in addition, it has to make allowances for the fact that the beam itself will widen as the distance from the ground transmitter increases. Also, the system has to be able to make the missile follow the beam with certainty for, once the beam has been "lost," only an amazing stroke of luck will enable it to be found again.

Fig. 9. Uneconomical beam-riding trajectory.

Unfortunately, the beam rider has an uneconomical trajectory for it will tend to spend a major part of its flight low down (Fig. 9). It is, therefore, apt to have a somewhat limited range.

However, for local defence against air attack, such as is needed by a ship at sea, the beam rider has many advantages. It is likely to be remarkably free from enemy interference. The head-on approach to the target means that the beam will not have to move too fast, even for a fast-moving target, so that there is less danger of the missile losing the beam. Furthermore, as the system depends on a very narrow beam, it is able to work remarkably close to the surface, particularly if that surface is relatively flat like the sea.

Homing Systems

However, the greatest philosophical objection to the beam rider, which applies also to any of the command systems, is that the farther the missile flies from the source of its information, the less accurate will this information become. Therefore,

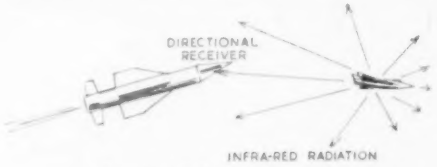

Fig. 10. Infra-red homing.

there is a strong case for using equipment within the missile that will home itself on to the target. In such a system, accuracy increases as the target is approached.

All aircraft emit heat and this can be picked up by an infra-red detecting device. This is sufficient, at short ranges, to establish the line of sight to the target (Fig. 10). Nearly half the field-of-battle anti-aircraft weapons use infra-red homing.

Semi-active Homing

For short- and medium-range anti-aircraft missiles, radar homing (Fig. 11) is preferred to infra-red detection. The radar dish in the missile is fitted with an aerial system similar to that used for the ground radar, so that any change in the direction of the target may be detected. However, as the missile dish is not attached to firm ground, but to a moving missile, it has to be stabilized.

In Fig. 12 is shown a radar dish stabilized by a gyroscope. The gyro wheel is mounted on gimbals and any misalignment of

Missile and Satellite Review . . . .

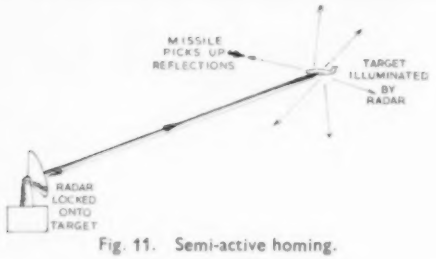

Fig. 11. Semi-active homing.

the outer case as compared with the gyro wheel is detected and passed to the motors to correct the orientation. For simplicity's sake, the dish servo amplifiers have been omitted and the gimbals on which the dish is mounted have been greatly simplified.

Any misalignment due to alterations in the line of sight to the target will be fed into the gyroscope to correct it and the motors will drive the dish holding the aerials to follow suit. Thus, the gyroscope is kept on the line of sight to the target

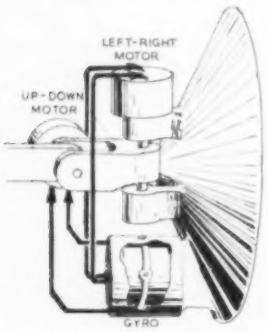

Fig. 12. Stabilization of dish.

and, therefore, is sometimes known as a "line-of-sight" gyroscope or a "bootstrap" gyroscope.

In practice, it may be better to use two rate gyroscopes. This preference for two gyros that each measure change of direction in one direction, rather than one gyro that measures change of direction in two directions, is also a feature of inertial navigation. The preference arises largely because it is so difficult to balance a gyroscope in two directions simultaneously.

A little thought shows that, as the missile is connected to the dish through the dish gimbals and the dish servo motors, the rate gyroscopes on the dish can also stabilize the missile and can be used for the control system. However, in certain missiles the radar needs to be designed so that the dish can almost look sideways and, in this event, the dish gyroscopes will be so far out of alignment with the missile that separate rate gyroscopes for missile control will be required.

Radar homing of this type is so commonly used for ground-based anti-aircraft missiles that these weapons are often known as SAGW (semi-active guided weapons). However, the system is less common in airborne anti-aircraft missiles because this would demand a powerful radar transmitter in the launching aircraft which would be expensive in space, weight and power. Hence air-to-air missiles are seldom designed with a range that cannot be managed by infra-red homing or visual guidance.

The radar searchlight for semi-active homing will need to be laid on to the target. However, the dish within the missile will not have time to search and find its target and, therefore, means must be provided whereby the gyroscopes controlling the dish are precessed so that the dish starts by pointing towards the target. This process, known as "acquiring the target," is achieved by aligning the dish of the missile with the dish of the illuminating radar before launching the missile.

Active Homing

In the instance of long-range anti-aircraft weapons used for area defence, the distance from ground-based radar will make a radio command or a beam-riding system ineffective and, furthermore, the ground radar may not be able to illuminate the target. The missile will, therefore, have to provide its own transmitter and thus we arrive at the so-called active system

Fig. 13. Active homing system.

illustrated in Fig. 13. Obviously, this will demand complex and heavy equipment in the missile.

However, as the range of the active missile system is likely to be too low for extended area defence, it follows that initially, at least, the missile will have to be guided by a command or beam system to the point where its active homing system can take over to provide the kill. Indeed, this system of providing mid-course guidance as well as final homing is sometimes applied to medium-range semi-active homing missiles.

Evidently these medium- and long-range active homing missiles are at the exact opposite end of the scale to the radio command missile. While the latter relies on a simple missile supported by very complex ground equipment, the former not only carries its own radar with stabilized dish, transmitter, receiver and computer, but also may have to carry an additional receiver for guidance during the early stages of its flight.

Proportional Navigation

In radio command or beam riding, the missile or the ground computer has to know the position of the target and of the missile also. In the case of homing, all that needs to be known is the line of sight from the missile to the target. Once this line of sight is established, by means of the rate gyroscopes that stabilize the radar dish, the course which the missile must steer for the strike can be calculated.

The calculation of the course to intercept is achieved by a system known as "proportional navigation." This, in direct contrast to the interception theory taught in text books on air navigation, is extremely simple. It merely says that the missile must alter course in the direction of the target at least as quickly as the line of sight to the target is altering.

(*Continued on page 501*)

TABLE 3

GUIDANCE SYSTEMS SUMMARY—Percentage Use of Various Techniques.

Class of missile	Description	Range (n.m.)	Inertial nav.		Map reading	Homing			Radio		Visual		Spin stabilized or not stabilized
			Pure	Hybrid		Active	Semi-active	Infra-red	Beam	Command	Radio link	Wire link	
Strategic SSM	ICBM—Very long range ballistic	5,500	60	40	—	—	—	—	—	—	—	—	—
	LRBM—Long range ballistic	2,000	80	20	—	—	—	—	—	—	—	—	—
	Pilotless long-range bomber	1,000–5,000	—	70	30	—	—	—	—	—	—	—	—
Tactical SSM	MRBM—Medium-range ballistic	150	80	—	—	—	—	—	—	20	—	—	—
	Short-range missile	10	—	—	—	—	—	—	—	80	20	—	—
	Short-range ballistic	10	20	—	—	—	—	—	—	—	—	—	80
	Field of battle—anti-tank and ship	2	—	—	—	—	—	—	—	*10	10	80	—
	Field of battle—infantry	1	—	—	—	—	—	—	—	—	—	100	—
Strategic ASM	Stand-off bomb—medium range	300	60	20	—	—	—	—	—	†20	—	—	—
Tactical ASM	Powered bomb—short range	10	10	—	—	—	—	—	—	†40	50	—	—
SAM	ABM—Anti ballistic missile	200	—	—	—	—	—	—	—	‡100	—	—	—
	Area defence—semi aircraft	250	—	—	—	§100	—	—	—	—	—	—	—
	Medium range	60	—	—	—	—	§80	—	20	—	—	—	—
	Short range	20	—	—	—	—	50	—	30	20	—	—	—
	Field of battle	4	—	—	—	—	—	40	10	—	50	—	—
AAM	Short range and field of battle	5	—	—	—	5	10	50	20	—	10	—	5

* Includes acoustic homers. † Includes types that home onto enemy radar. ‡ May also have some form of terminal guidance. § May include mid-course guidance.

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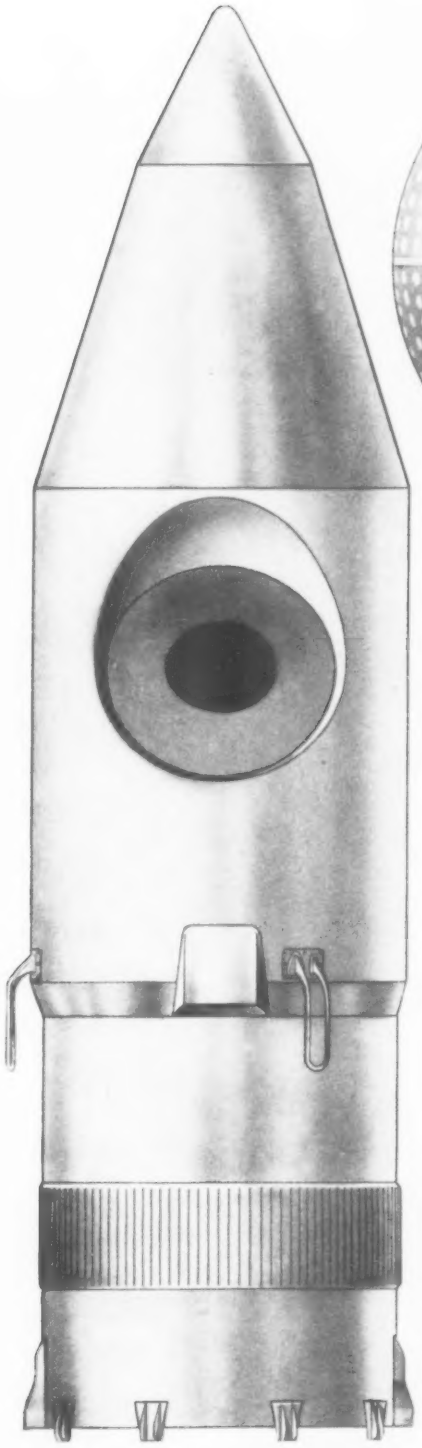
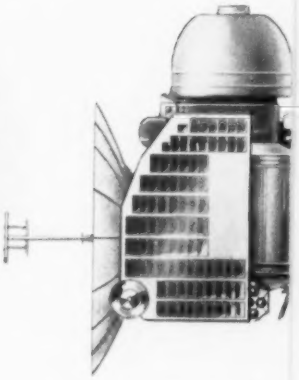


VOSTOK I (provisional)*

*This drawing has been largely based on the exhibit suspended beneath a Mig-6 helicopter at the Tushino air display on July 9; it omits the tail-annulus.

EXPLORER IX



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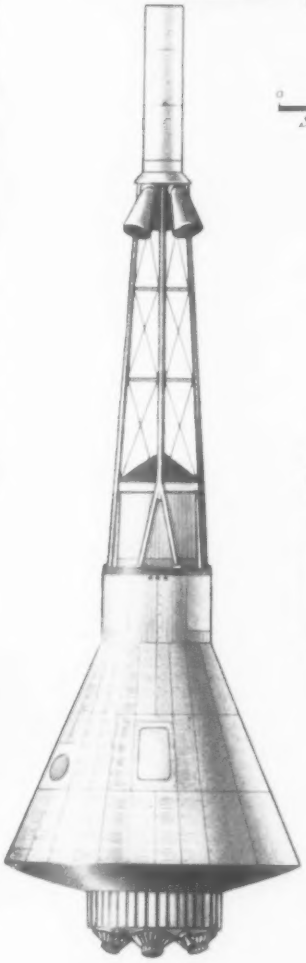

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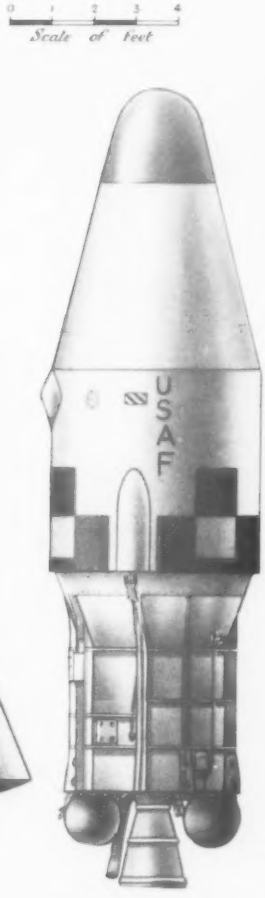

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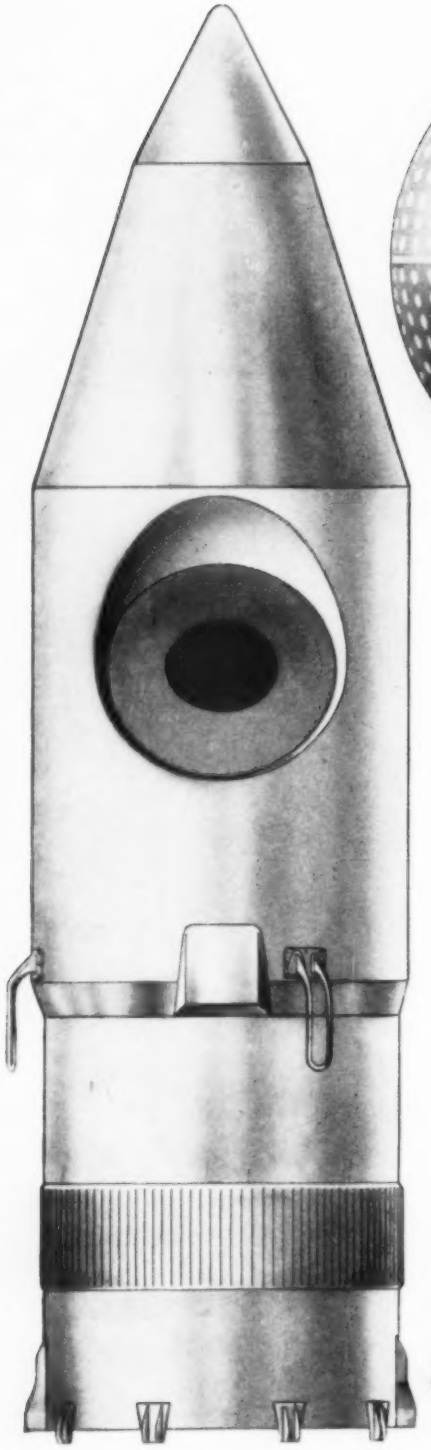

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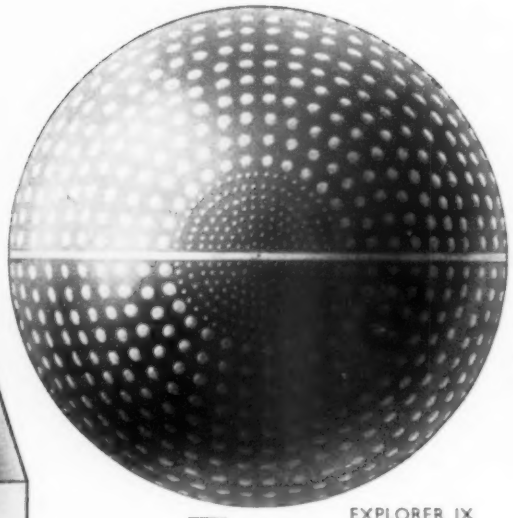

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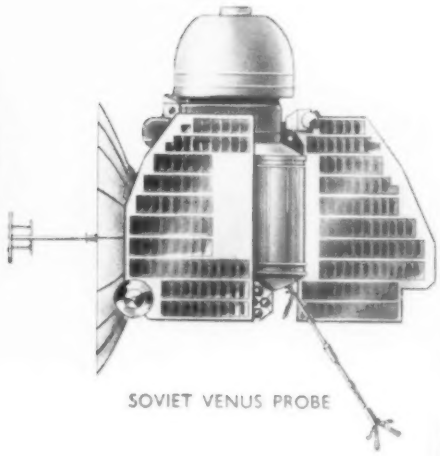

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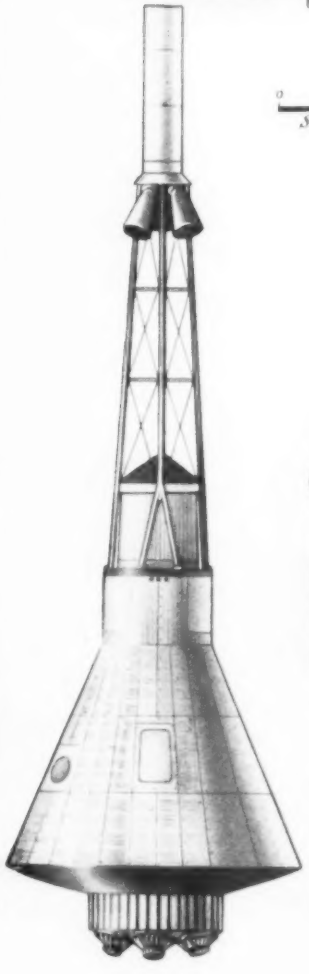

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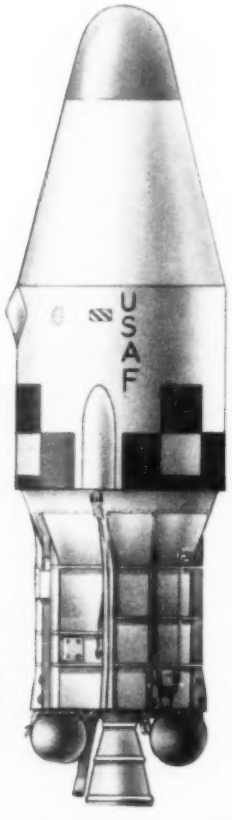

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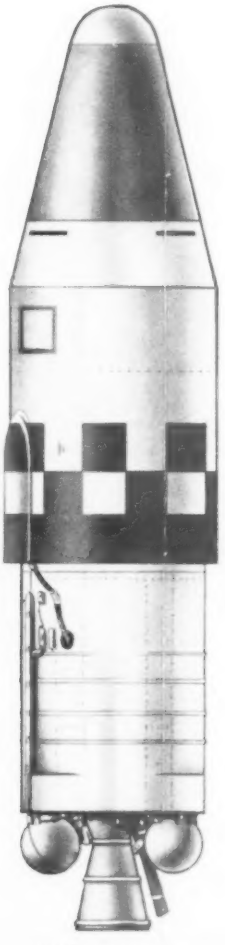

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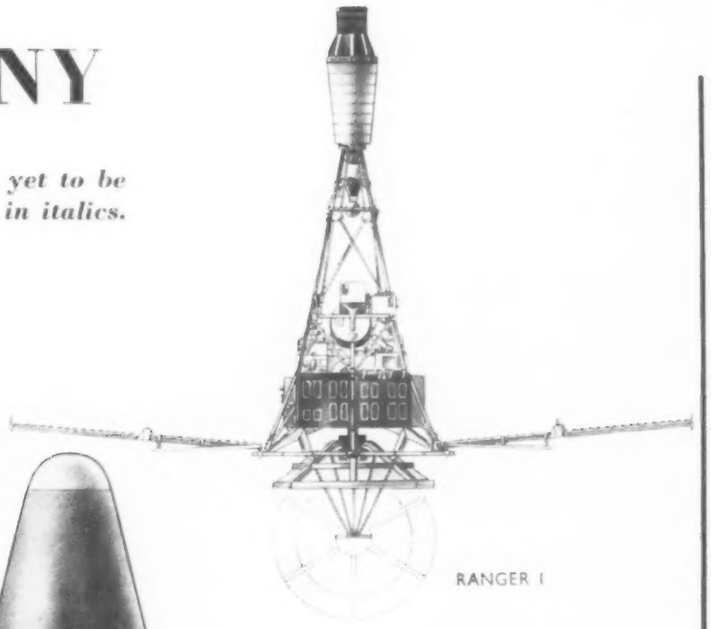

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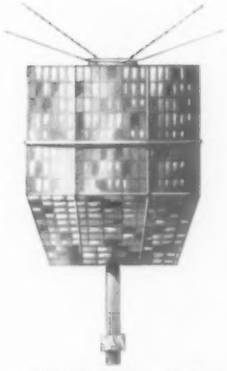

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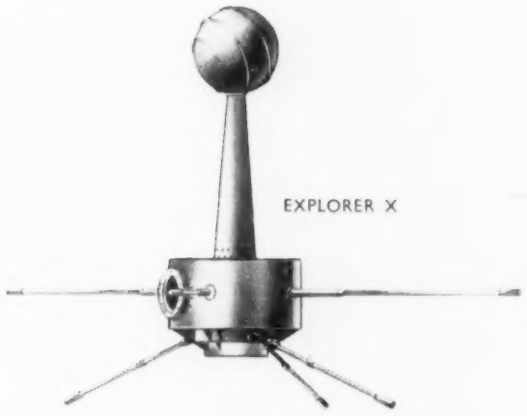

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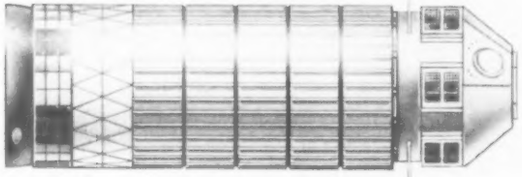

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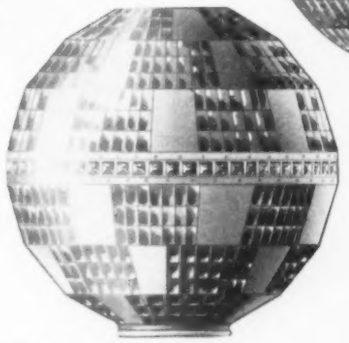

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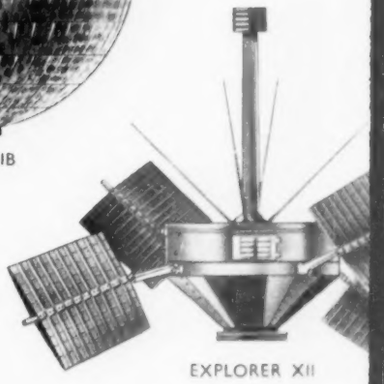

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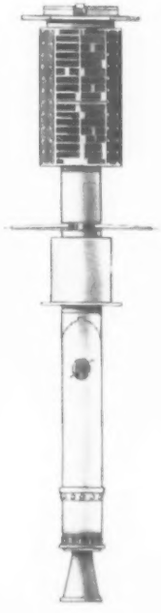

EXPLORER XI

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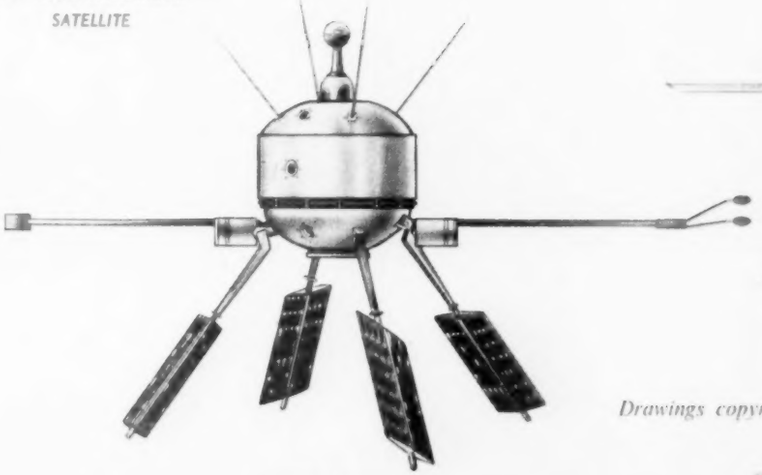

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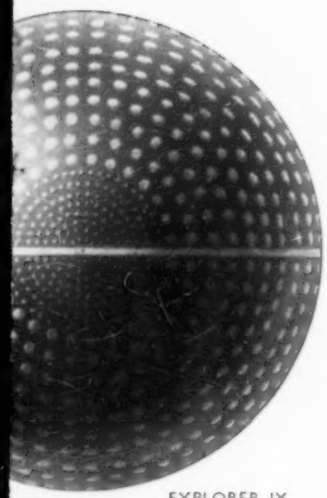

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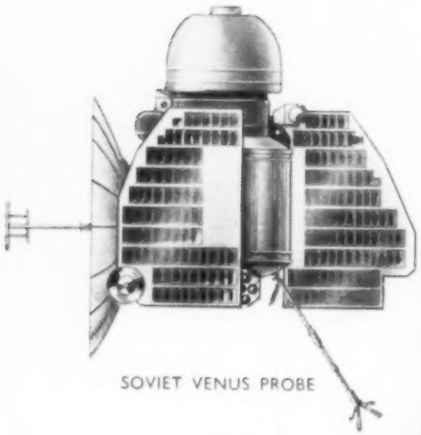

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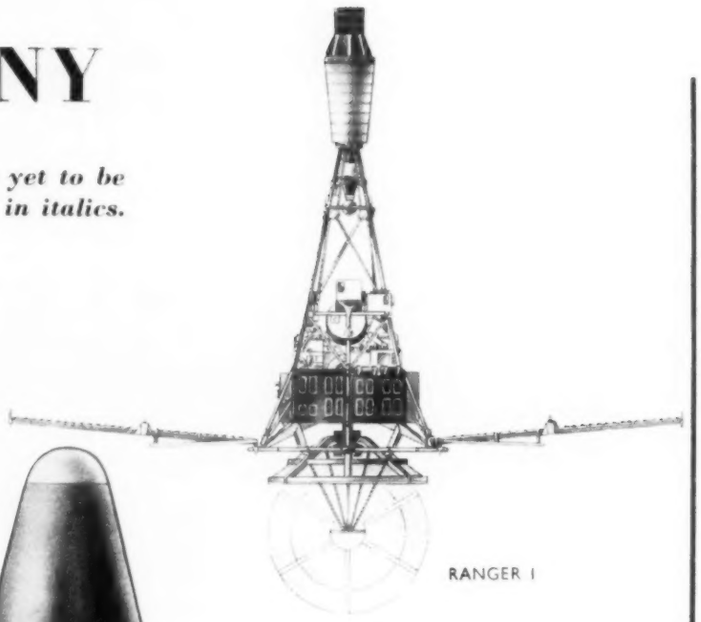

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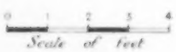

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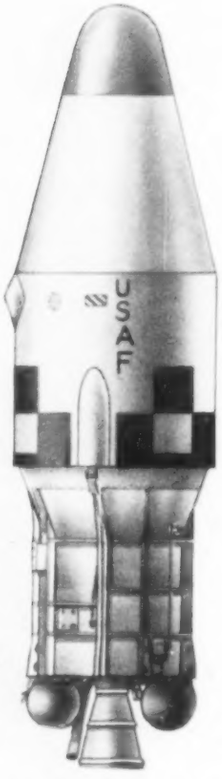

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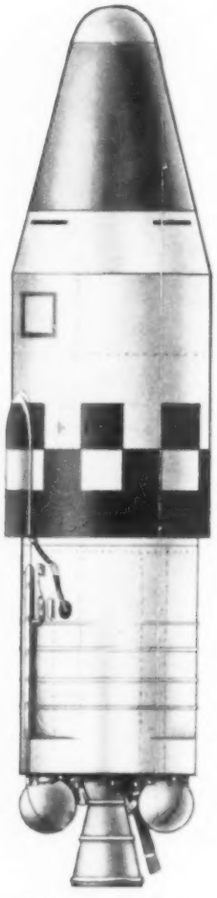

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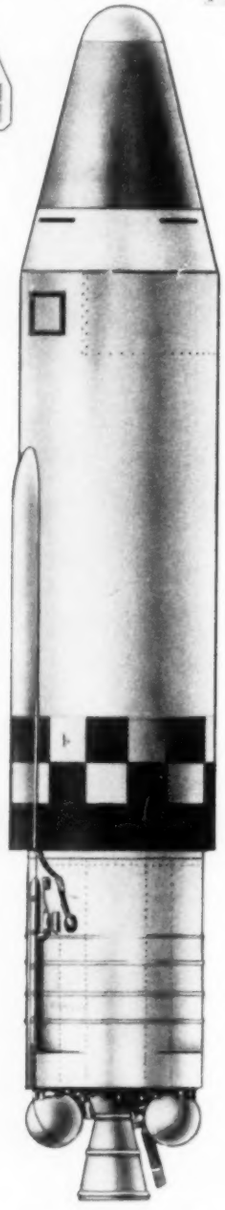

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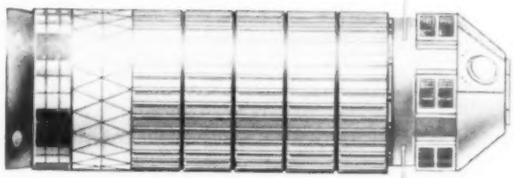

EXPLORER XIII

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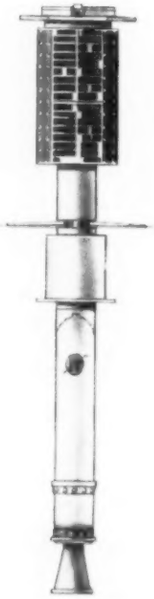

EXPLORER XI

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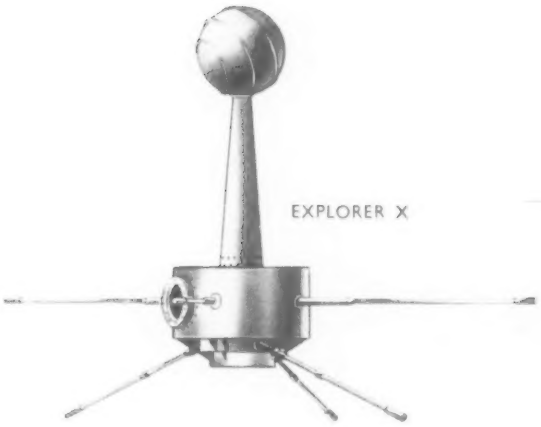

EXPLORER X

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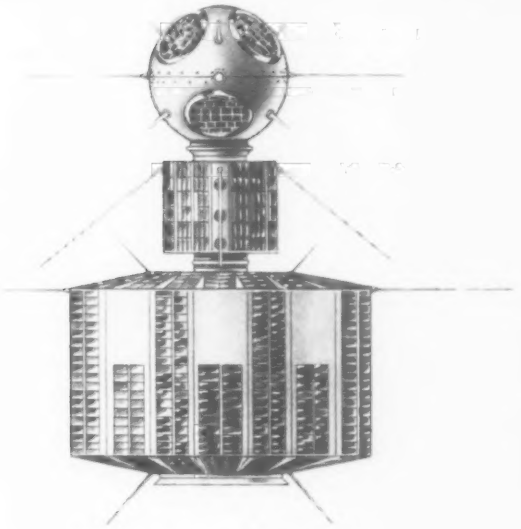

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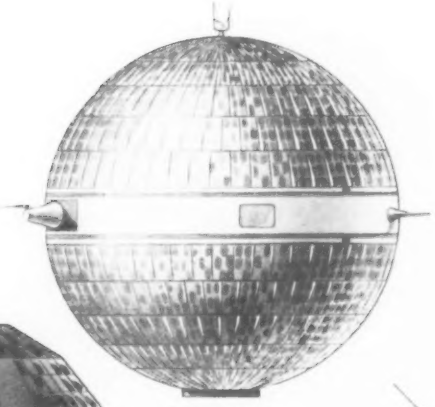

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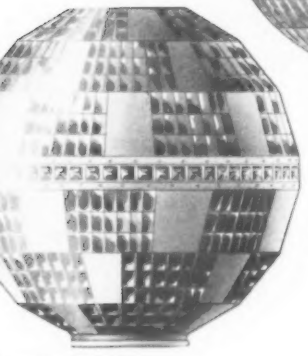

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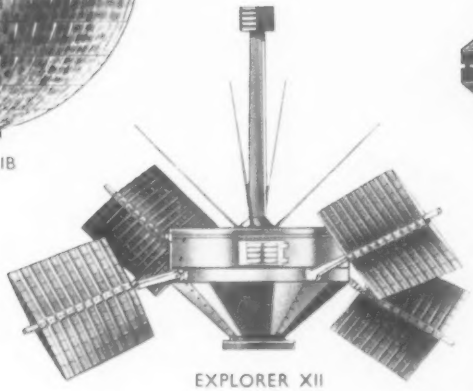
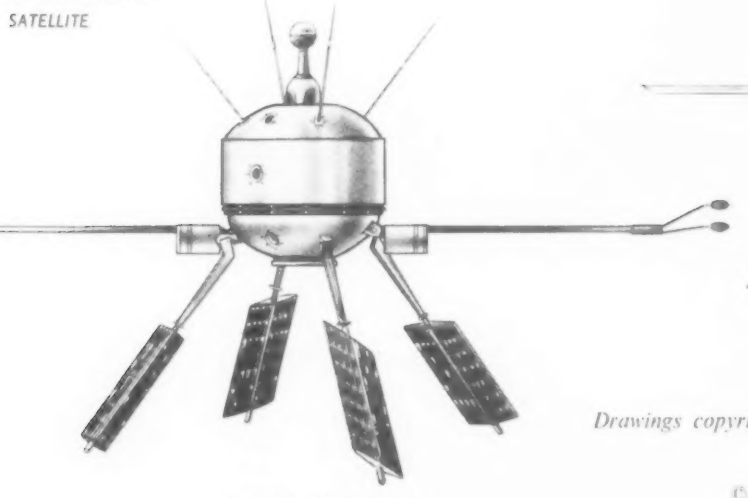
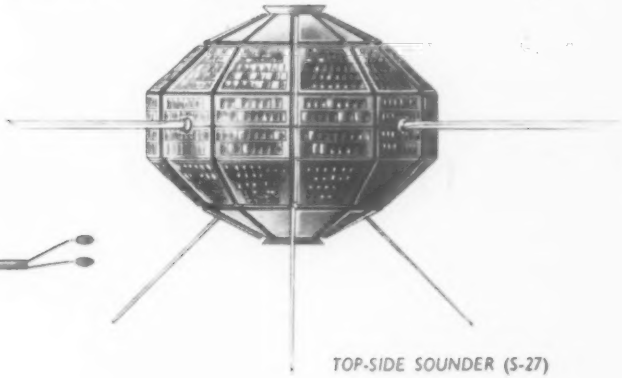


EXPLORER XII



U.K./U.S. SCOUT I (S-51)



TOP-SIDE SOUNDER (S-27)

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Record of all known Space-vehicle Launchings*

(Continued from our issues of Aug. 28, 1959, and Aug. 12, 1960, and corrected to Sept. 17, 1961)

Name	Date	Shape and size	Weight	Shell material	Purpose	Radio				Orbit				Launching site and vehicle
						Frequency power	Lifetime	Power supply	Antennae	Perigee	Apogee	Period	Inclination to equator	
			lb.			Mc/s.				miles	miles	min.	deg.	
Discoverer XIII	Aug. 10, 1960	Cone-tipped cylinder 19.2 ft. x 5 ft. capsule 27 in. x 33 in. dia.	1,700 (total including empty second stage and 300 lb. recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. Obtain data on propulsion, orbital performance, and advanced engineering tests.	Not disclosed	Not disclosed	Nickel-cadmium batteries	1 directional, 1 whip	161	436	94.1	82.51	Vandenberg A.F.B.; Thor-Agena A, launch weight 108,500 lb. (approx.).
						Capsule ejected and recovered from sea on Aug. 11, 1960								
Echo I	Aug. 12, 1960	(a) Sphere 26.5 in. dia. (package); (b) 100 ft. (inflated satellite)	(a) 24 (b) 136	(a) Magnesium (b) Mylar polyester covered with aluminium, vapour-deposited	Passive reflector for radio-communication experiments (Aluminium covering provides 98% reflectivity of radio waves up to 20,000 Mc/s.)	108.06 at 60 mw. (in third stage). 107.94 at 10 mw. (2 beacons on balloon)	Indefinite	Mercury batteries in third stage. Nickel-cadmium batteries and solar cells on balloon	Not disclosed	945	1,049	118.3	47.2	Cape Canaveral; Thor-Delta, launch weight 112,000 lb. (approx.)
Discoverer XIV	Aug. 18, 1960	As Discoverer XIII	As Discoverer XIII	Not disclosed	As Discoverer XIII.	Not disclosed	Not disclosed	As Discoverer XIII	1 directional, 1 whip	116	502	94.5	79.6	Vandenberg A.F.B.; Thor-Agena A, launch weight 108,500 lb. (approx.).
						(Capsule ejected on Aug. 19 and air-snatched by C-119)								
Courier IA	Aug. 18, 1960	Sphere 51 in. dia.	500	Epoxy glass fibre	Test feasibility of global military communications network using "delayed repeater" satellites which receive information until commanded to transmit.	4 microwave transmitters and 4 receivers; FM, VHF telemetry trans., 50 mw.	Not applicable	Nickel-cadmium batteries; 19,200 solar cells	Two microwave	FAILED TO ORBIT (Launching rocket exploded after some 2½ min.)				Cape Canaveral; Thor-Able Star, launch weight 105,000 lb. (approx.).
Spacecraft II (Sputnik V)	Aug. 19, 1960	Cone-tipped cylinder (?)	10,120	Not disclosed	Test safety of capsule and recovery system with animals, two dogs, rats, mice, flies and plants, seeds, etc.	19,995, etc.	Duration of mission	Chemical batteries and solar cells	Not disclosed	190	211	90.72	64.57	Baykonur (?), multi-stage booster.
						Spacecraft and ejected dog-capsule successfully recovered after 17 orbits.								
Discoverer XV	Sept. 13, 1960	As Discoverer XIII	As Discoverer XIII	Not disclosed	As Discoverer XIII.	Not disclosed	Not disclosed	As Discoverer XIII	1 directional, 1 whip	130	472	94.24	80.93	Vandenberg A.F.B.; Thor-Agena A, launch weight 108,5000 lb. (approx.).
						(Capsule ejected on Sept. 15 but lost in sea)								
Pioneer	Sept. 25, 1960	Sphere 39 in. dia., with four 24 in. x 24 in. solar-cell "paddles"	387	Aluminium-alloy	Investigate environment between Earth and Moon and develop technique for controlling spacecraft remotely from Earth. Instruments included: micrometeorite impact detector; high-energy radiation counter; equip't. for measuring total rad. flux and low-energy range of radiation spectrum; two magnetometers; sun scanner; scintillation spectrometer; plasma probe.	Two 1.5 W. UHF operating at 378 Mc/s.	Not applicable	Nickel-cadmium batteries and 8,800 solar cells	Not disclosed	FAILED IN MISSION (Abnormal burning in second stage failed to provide necessary velocity; vehicle destroyed on re-entry.)				Cape Canaveral; Atlas-Able, launch weight 260,000 lb. (approx.).
Courier IB	Oct. 4, 1960	Sphere 51 in. dia.	500	Epoxy glass fibre	As Courier IA.	200 to 7,000 Mc/s. range (See also Courier IA)	Indefinite	As Courier IA	2 microwave, 4 whip	604	751	106.9	28	Cape Canaveral; Thor-Able Star, launch weight 105,000 lb. (approx.).
Samos I	Oct. 11, 1960	Cone-tipped cylinder 22 ft. x 5 ft. dia.	4,100, incl. second stage casing	Not disclosed	Determine engineering feasibility of obtaining ground observation from satellite in orbit. Embodied photographic and related test equipment—	Not disclosed	Not applicable	Not disclosed	Not disclosed	FAILED TO ORBIT (Second stage did not attain orbital velocity)				Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).

Samos I	Oct. 11, 1960	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,100, incl. second stage casing	Not disclosed	Determine engineering feasibility of obtaining ground observation from satellite in orbit. Embodied photographic and related test equipment—also telemetry, radiation, tracking and command equipment.	Not disclosed	Not applicable	Not disclosed	Not disclosed	(Second stage did not attain orbital velocity)			Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).
Discoverer XVI	Oct. 26, 1960	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100, incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Ejection and recovery of capsule from orbit. Systems evaluation of new Agena B satellite.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Second stage did not separate)			Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Explorer VIII	Nov. 3, 1960 (est. 10 years)	Two truncated cones joined at bases 30 in. high × 30 in. dia.	90.14	Not disclosed	Investigate ionosphere—carried single-grid ion trap; four multi-grid ion traps; electric field meter; photomultiplier; micrometeorite microphone; four thermistors, and sensor to measure electron temperature.	108 at 70 mw.	2 to 3 months	Mercury batteries	Dipole	258	1,423	112.7	49.9	Cape Canaveral; Juno II, launch weight 121,000 lb. (approx.).
Discoverer XVII	Nov. 12	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Place Agena B satellite in near polar orbit and recover capsule. Latter contained radiation counter and emulsion pack; microscopic, artificially grown, human cells, and high intensity light beacon for optical tracking.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	116	616	96.45	81.8	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (appr. (Capsule air-snatched by C-119 on Nov. 14, 1960)
Tiros II	Nov. 23, 1960 (50–100 years.)	Cylinder 19 in. high × 42 in. dia.	280	Aluminium/stainless steel	Test experimental TV and infra-red techniques leading to global meteorological information system. Includes one wide and one narrow-angle TV camera and IR-sensors to map radiation in various spectral bands.	Two 235 Mc/s. at 2 W; one 237.8 Mc/s. at 3 W; two 30 mw. tracking beacons on 108 and 108.03 Mc/s.	Indefinite	Nickel-cadmium batteries and 9,200 solar cells	4 rods (transmitting), 1 rod (receiving)	387	453	98.2	48.5	Cape Canaveral; Thor Delta, launch weight 112,000 lb. (approx.).
Transit IIIA and NRL II	Nov. 30	(a) Sphere 36 in. dia. (b) Sphere 20 in. dia.	(a) 203 (b) 40	(a) Two glass fibre skins with nylon-phenotic honeycomb filler (b) Aluminium	(a) Develop all-weather global navigational satellite for ships and aircraft; also obtain more precise geodetic measurements. (b) "pick-a-back" satellite to measure solar radiation.	(a) 54,162, 216 and 324 Mc/s. (b) 108 Mc/s.	Not applicable	(a) and (b), storage batteries and solar cells	(a) broad band spiral (b) 4 rods	FAILED TO ORBIT (Destroyed by range safety officer shortly after lift-off when Thor engine prematurely closed down)			Cape Canaveral; Thor-Able Star; launch weight 120,000 lb. (approx.).
Spacecraft III (Sputnik VI)	Dec. 1	Cone-tipped cylinder (?)	10,060	Not disclosed	Preliminary test for subsequent manned vehicle; carried two dogs and variety of other animal and plant life.	19.995 Mc/s.	More than 24 hr.	Storage batteries and solar cells	Not disclosed	112	155	88.6	65	Baykonur (?); multi-stage booster. (Capsule burned up on re-entry on Dec. 2, 1960)
Explorer	Dec. 4	Sphere, 12 ft. dia.	87 total, incl. 14 lb. sphere and 73 lb. of ejection, inflation and telemetry equipment	Sphere of Mylar plastic film and aluminium foil	Study performance and control system of Scout launch vehicle; orbit inflatable satellite for drag studies.	136 Mc/s. at 15 mw.	Not applicable	Miniature storage batteries and 280 solar cells	Two hemispheres aluminium foil	FAILED TO ORBIT (Second stage did not ignite)				Wallops Island; Scout; launch weight 36,100 lb.
Discoverer XVIII	Dec. 8	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Place Agena B satellite in near-polar orbit and recover capsule. Latter contained algae, bone marrow, membrane from eyelid, gamma globulin, spores, gold foil, analine powder and other materials. Embodied high-intensity light beacon.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	154	459	94.1	80.9	Vandenberg A.F.B.; Thor-Agena B (modified Thor I.R.B.M. with 10% more thrust than previous Thor boosters); launch weight 115,500 lb. (approx.). (Capsule air-snatched by C-119 on Dec. 10, 1960)
Pioneer	Dec. 15	Sphere 39 in. dia. with four 24 in. × 24 in. solar-cell "paddles"	388	Aluminium-alloy	Same as Pioneer for Sept. 25, 1960; similar range of experiments.	Two 1.5 W. UHF operating at 378 Mc/s.	Not applicable	Nickel cadmium batteries and 8,800 solar cells	Not disclosed	FAILED IN MISSION (Atlas booster exploded after 70 sec. at about 40,000 ft.)				Cape Canaveral; Atlas-Able; launch weight more than 260,000 lb.
Discoverer XIX	Dec. 20	As Discoverer XVI	2,100 (total)	Not disclosed	Systems evaluation of Agena B satellite; collect data on atmospheric phenomena and IR-radiation in Earth's atmosphere in support of programmes such as Midas.	Not disclosed	Ceased transmitting Dec. 25, 1960	Not disclosed	1 directional, 1 whip	128	328	92	83.4	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Samos II	Jan. 31	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,100 incl. second stage casing	Not disclosed	Same as Samos I.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	300 (appx.)	350 (appx.)	95 (appx.)	Near polar	Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).
Sputnik VII	Feb. 4, 1961 (re-entered Feb. 26, 1961)	Not disclosed	14,292	Not disclosed	Establish heavy satellite in precise orbit; possibly control experiment for Sputnik VIII probe launcher.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	138.75	203.56	89.80	64	Baykonur (?); multi-stage booster.
Sputnik VIII (Venus probe)	Feb. 12, 1961 (Sputnik re-entered Feb. 25, 1961)	(a) Sputnik, not disclosed (b) Complex 80 in. long × 41 in. dia. with solar cell panels, etc.	(a) Not disclosed (b) 1,419	Not disclosed	Test of orientatable Sputnik as directional "launching platform" for Venus probe. Radio contact with latter lost on or about Feb. 27, 1961; Russians predicted that probe would pass within 62,500 miles of Venus between May 19–20, 1961.	(b) 922.8 Mc/s. on command	At least 97 days intermittent transmission intended	Storage batteries and solar cells in (b)	Omnidirectional 8 ft. long; 2 cross; parabolic directional "dish" over 6 ft. dia.	66.7 million (perihelion)	94.6 million (aphelion)	300 (days)	0.3 (to ecliptic)	Baykonur (?); multi-stage booster.
Explorer IX	Feb. 16	Sphere 12 ft. dia.	80 total incl. 15 lb. sphere and 65 lb. of ejection, inflation and telemetry equipment	Sphere of Mylar plastic film and aluminium foil	Same as Explorer for Dec. 4, 1960. Balloon transmitter failed to function properly.	136 Mc/s. at 15 Mw.	Not applicable	Miniature storage batteries and 280 solar cells	Two hemispheres aluminium foil	395	1,605	118.3	38.63	Wallops Island; Scout; launch weight 36,600 lb. (approx.).
Discoverer XX	Feb. 17, 1961	As Discoverer XVI	2,450 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Systems evaluation of Agena B satellite—also modified stabilization system. Re-entry capsule carried four samples of silicon test materials for studying effect of high energy protons on silicon used in transistors and solar cells.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	177	486	95.4	80.43	Vandenberg A.F.B.; Thor-Agena B; launch weight 123,800 lb. (approx.). (Fault developed in satellite; no attempt to recover capsule)
Discoverer XXI	Feb. 18	Cone-tipped cylinder 25 ft. long × 5 ft. dia.	Not disclosed	Not disclosed	Gather data on atmospheric phenomena and IR-radiation in atmosphere in support of U.S.A.F. early-warning satellite system, and test satellite stabilization and control [illegible] successfully re-	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	149	659	93.8 97.8 (after restart)	80.74	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).

Discoverer XIII	Aug. 10, 1960	Cone-tipped cylinder 19.2 ft. × 5 ft. capsule 27 in. × 33 in. dia.	lb. 1,700 (total including empty second stage and 300 lb. recovery capsule)	Not disclosed	Ejection and recovery of capsule from orbit. Obtain data on propulsion, orbital performance, and advanced engineering tests.	Mc/s. Not disclosed	Not disclosed	Nickel-cadmium batteries	1 directional, 1 whip	miles 161 / miles 436 / min. 94.1 / deg. 82.51 — Capsule ejected and recovered from sea on Aug. 11, 1960				Vandenberg A.F.B.; Thor-Agena A, launch weight 108,500 lb. (approx.).
Echo I	Aug. 12, 1960	(a) Sphere 26.5 in. dia. (package); (b) 100 ft. (inflated satellite)	(a) 24 (b) 136	(a) Magnesium (b) Mylar polyester covered with aluminium, vapour-deposited	Passive reflector for radio-communication experiments (Aluminium covering provides 98% reflectivity of radio waves up to 20,000 Mc/s.)	108.06 at 60 mw. (in third stage). 107.94 at 10 mw. (2 beacons on balloon)	Indefinite	Mercury batteries in third stage. Nickel-cadmium batteries and solar cells on balloon	Not disclosed	945	1,049	118.3	47.2		Cape Canaveral; Thor-Delta, launch weight 112,000 lb. (approx.)
Discoverer XIV	Aug. 18, 1960	As Discoverer XIII	As Discoverer XIII	Not disclosed	As Discoverer XIII.	Not disclosed	Not disclosed	As Discoverer XIII	1 directional, 1 whip	116	502	94.5	79.6	(Capsule ejected on Aug. 19 and air-snatched by C-119)	Vandenberg A.F.B.; Thor-Agena A, launch weight 108,500 lb. (approx.).
Courier IA	Aug. 18, 1960	Sphere 51 in. dia.	500	Epoxy glass fibre	Test feasibility of global military communications network using "delayed repeater" satellites which receive information until commanded to transmit.	4 microwave transmitters and 4 receivers; FM, VHF telemetry trans., 50 mw.	Not applicable	Nickel-cadmium batteries; 19,200 solar cells	Two microwave	FAILED TO ORBIT (Launching rocket exploded after some 2½ min.)					Cape Canaveral; Thor-Able Star, launch weight 105,000 lb. (approx.).
Spacecraft II (Sputnik V)	Aug. 19, 1960	Cone-tipped cylinder (?)	10,120	Not disclosed	Test safety of capsule and recovery system with animals, two dogs, rats, mice, flies and plants, seeds, etc.	19.995, etc.	Duration of mission	Chemical batteries and solar cells	Not disclosed	190	211	90.72	64.57	Spacecraft and ejected dog-capsule successfully recovered after 17 orbits.	Baykonur (?), multi-stage booster.
Discoverer XV	Sept. 13, 1960	As Discoverer XIII	As Discoverer XIII	Not disclosed	As Discoverer XIII.	Not disclosed	Not disclosed	As Discoverer XIII	1 directional, 1 whip	130	472	94.24	80.93	(Capsule ejected on Sept. 15 but lost in sea)	Vandenberg A.F.B.; Thor-Agena A, launch weight 108,5000 lb. (approx.).
Pioneer	Sept. 25, 1960	Sphere 39 in. dia., with four 24 in. × 24 in. solar-cell "paddles"	387	Aluminium-alloy	Investigate environment between Earth and Moon and develop technique for controlling spacecraft remotely from Earth. Instruments included: micrometeorite impact detector; high-energy radiation counter; equip't. for measuring total rad. flux and low-energy range of radiation spectrum; two magnetometers; sun scanner; scintillation spectrometer; plasma probe.	Two 1.5 W. UHF operating at 378 Mc/s.	Not applicable	Nickel-cadmium batteries and 8,800 solar cells	Not disclosed	FAILED IN MISSION (Abnormal burning in second stage failed to provide necessary velocity; vehicle destroyed on re-entry.)					Cape Canaveral; Atlas-Able, launch weight 260,000 lb. (approx.).
Courier IB	Oct. 4, 1960	Sphere 51 in. dia.	500	Epoxy glass fibre	As Courier IA.	200 to 7,000 Mc/s. range (See also Courier IA)	Indefinite	As Courier IA	2 microwave, 4 whip	604	751	106.9	28		Cape Canaveral; Thor-Able Star, launch weight 105,000 lb. (approx.).
Samos I	Oct. 11, 1960	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,100, incl. second stage casing	Not disclosed	Determine engineering feasibility of obtaining ground observation from satellite in orbit. Embodied photographic and related test equipment—also telemetry, radiation, tracking and command equipment.	Not disclosed	Not applicable	Not disclosed	Not disclosed	FAILED TO ORBIT (Second stage did not attain orbital velocity)					Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).
Discoverer XVI	Oct. 26, 1960	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100, incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Ejection and recovery of capsule from orbit. Systems evalustion of new Agena B satellite.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Second stage did not separate)					Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Explorer VIII	Nov. 3, 1960 (est. 10 years)	Two truncated cones joined at bases 30 in. high × 30 in. dia.	90.14	Not disclosed	Investigate ionosphere—carried single-grid ion trap; four multi-grid ion traps; electric field meter; photomultiplier; micrometeorite microphone; four thermistors, and sensor to measure electron temperature.	108 at 70 mw.	2 to 3 months	Mercury batteries	Dipole	258	1,423	112.7	49.9		Cape Canaveral; Juno II, launch weight 121,000 lb. (approx.).
Discoverer XVII	Nov. 12	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Place Agena B satellite in near polar orbit and recover capsule. Latter contained radiation counter and emulsion pack; microscopic, artificially grown, human cells, and high intensity light beacon for optical tracking.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	116	616	96.45	81.8	(Capsule air-snatched by C-119 on Nov. 14, 1960)	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Tiros II	Nov. 23, 1960 (50–100 years.)	Cylinder 19 in. high × 42 in. dia.	280	Aluminium/stainless steel	Test experimental TV and infra-red techniques leading to global meteorological information system. Includes one wide and one narrow-angle TV camera and IR-sensors to map radiation in various spectral bands.	Two 235 Mc/s. at 2 W; one 237.8 Mc/s. at 3 W; two 30 mw. tracking beacons on 108 and 108.03 Mc/s.	Indefinite	Nickel-cadmium batteries and 9,200 solar cells	4 rods (transmitting), 1 rod (receiving)	387	453	98.2	48.5		Cape Canaveral; Thor Delta, launch weight 112,000 lb. (approx.).
Transit IIIA and NRL II	Nov. 30	(a) Sphere 36 in. dia. (b) Sphere 20 in. dia.	(a) 203 (b) 40	(a) Two glass fibre skins with nylon-phenotic honeycomb filler (b) Aluminium	(a) Develop all-weather global navigational satellite for ships and aircraft; also obtain more precise geodetic measurements. (b) "pick-a-back" satellite to measure solar radiation.	(a) 54,162, 216 and 324 Mc/s. (b) 108 Mc/s.	Not applicable	(a) and (b), storage batteries and solar cells	(a) broad band spiral (b) 4 rods	FAILED TO ORBIT (Destroyed by range safety officer shortly after lift-off when Thor engine prematurely closed down)					Cape Canaveral; Thor-Able Star; launch weight 120,000 lb. (approx.).
Spacecraft III (Sputnik VI)	Dec. 1	Cone-tipped cylinder (?)	10,060	Not disclosed	Preliminary test for subsequent manned vehicle; carried two dogs and variety of other animal and plant life.	19.995 Mc/s.	More than 24 hr.	Storage batteries and solar cells	Not disclosed	112	155	88.6	65	(Capsule burned up on re-entry on Dec. 2, 1960)	Baykonur (?); multi-stage booster.
Explorer	Dec. 4	Sphere, 12 ft. dia.	87 total, incl. 14 lb. sphere and 73 lb. of ejection, inflation and telemetry equipment	Sphere of Mylar plastic film and aluminium foil	Study performance and control system of Scout launch vehicle; orbit inflatable satellite for drag studies.	136 Mc/s. at 15 mw.	Not applicable	Miniature storage batteries and 280 solar cells	Two hemispheres aluminium foil	FAILED TO ORBIT (Second stage did not ignite)					Wallops Island; Scout; launch weight 36,100 lb.
Discoverer XVIII	Dec. 8	Cone-tipped cylinder 25 ft. × 5 ft. dia., capsule 27 in. × 33 in. dia.	2,100 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Place Agena B satellite in near-polar orbit and recover capsule. Latter contained algae, bone marrow, membrane from eyelid, gamma globulin, spores, gold foil, analine powder and other materials. Embodied high-intensity light beacon.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	154	459	94.1	80.9	(Capsule air-snatched by C-119 on Dec. 10, 1960)	Vandenberg A.F.B.; Thor-Agena B (modified Thor I.R.B.M. with 10% more thrust than previous Thor boosters); launch weight 115,500 lb. (approx.).

		× 33 in. dia.	entry capsule		brane from eyelid, gamma globulin, spores, gold foil, analine powder and other materials. Embodied high-intensity light beacon.									Thor boosters); launch weight 115,500 lb. (approx.).
Pioneer	Dec. 15	Sphere 39 in. dia. with four 24 in. × 24 in. solar-cell "paddles"	388	Aluminium-alloy	Same as Pioneer for Sept. 25, 1960; similar range of experiments.	Two 1.5 W. UHF operating at 378 Mc/s.	Not applicable	Nickel cadmium batteries and 8,800 solar cells	Not disclosed	FAILED IN MISSION (Atlas booster exploded after 70 sec. at about 40,000 ft.)				Cape Canaveral; Atlas-Able; launch weight more than 260,000 lb.
Discoverer XIX	Dec. 20	As Discoverer XVI	2,100 (total)	Not disclosed	Systems evaluation of Agena B satellite; collect data on atmospheric phenomena and IR-radiation in Earth's atmosphere in support of programmes such as Midas.	Not disclosed	Ceased transmitting Dec. 25, 1960	Not disclosed	1 directional, 1 whip	128	328	92	83.4	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Samos II	Jan. 31	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,100 incl. second stage casing	Not disclosed	Same as Samos I.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	300 (appx.)	350 (appx.)	95 (appx.)	Near polar	Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).
Sputnik VII	Feb. 4, 1961 (re-entered Feb. 26, 1961)	Not disclosed	14,292	Not disclosed	Establish heavy satellite in precise orbit; possibly control experiment for Sputnik VIII probe launcher.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	138.75	203.56	89.80	64	Baykonur (?); multi-stage booster.
Sputnik VIII (Venus probe)	Feb. 12, 1961 (Sputnik re-entered Feb. 25, 1961)	(a) Sputnik, not disclosed (b) Complex 80 in. long × 41 in. dia. with solar cell panels, etc.	(a) Not disclosed (b) 1,419	Not disclosed	Test of orientatable Sputnik as directional "launching platform" for Venus probe. Radio contact with latter lost on or about Feb. 27, 1961; Russians predicted that probe would pass within 62,500 miles of Venus between May 19–20, 1961.	(b) 922.8 Mc/s. on command	At least 97 days intermittent transmission intended	Storage batteries and solar cells in (b)	Omnidirectional 8 ft. long; 2 cross-parabolic directional "dish" over 6 ft. dia.	66.7 million (perihelion)	94.6 million (aphelion)	300 (days)	0.3 (to ecliptic)	Baykonur (?); multi-stage booster.
Explorer IX	Feb. 16	Sphere 12 ft. dia.	80 total incl. 15 lb. sphere and 65 lb. of ejection, inflation and telemetry equipment	Sphere of Mylar plastic film and aluminium foil	Same as Explorer for Dec. 4, 1960. Balloon transmitter failed to function properly.	136 Mc/s. at 15 Mw.	Not applicable	Miniature storage batteries and 280 solar cells	Two hemispheres aluminium foil	395	1,605	118.3	38.63	Wallops Island; Scout; launch weight 36,600 lb. (approx.).
Discoverer XX	Feb. 17, 1961	As Discoverer XVI	2,450 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Systems evaluation of Agena B satellite—also modified stabilization system. Re-entry capsule carried four samples of silicon test materials for studying effect of high energy protons on silicon used in transistors and solar cells.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	177	486	95.4	80.43	Vandenberg A.F.B.; Thor-Agena B; launch weight 123,800 lb. (approx.).
										(Fault developed in satellite; no attempt to recover capsule)				
Discoverer XXI	Feb. 18	Cone-tipped cylinder 25 ft. long × 5 ft. dia.	Not disclosed	Not disclosed	Gather data on atmospheric phenomena and IR-radiation in atmosphere in support of U.S.A.F. early-warning satellite system, and test satellite stabilization and control. (Engine successfully re-started in orbit for first time.)	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	149	659	93.8 97.8 (after restart)	80.74	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Transit IIIB and Lofti	Feb. 21, 1961	(a) Sphere 36 in. dia. (b) Sphere 20 in. dia.	(a) 250 (b) 57	As Transit IIIA	(a) Same as Transit IIIA; (b) measure intensity of VLF (Very Low Frequency) signals through ionosphere.	(a) 54,324, 162, 216 Mc/s.; SECOR: 224, 421, 448 Mc/s. (b) 136 Mc/s.	Indefinite	(a) and (b) nickel-cadmium storage batteries and solar cells.	(a) broad band spiral; (b) 4 rods.	117	511	94.5	28.36	Cape Canaveral; Thor-Able Star; launch weight 120,000 lb. (approx.).
										(Satellites failed to separate)				
Explorer ..	Feb. 24	Two truncated cones joined at bases 24 in. high × 30 in. dia.	74	Aluminium	Investigate shape of ionosphere by analysis of signals transmitted by satellite on six frequencies using 14 channels of information.	20.005, 40.010, 41,010, 108.02, 360.09; 960.24 Mc/s.	Not applicable	Nickel-cadmium storage batteries and solar cells.	Loop, 6 in. dia.	FAILED TO ORBIT (Third and fourth stages did not ignite)				Cape Canaveral; Juno II; launch weight 121,000 lb. (approx.).
Spacecraft IV .. (Sputnik IX)	Mar. 9, 1961	Cone-tipped cylinder (?)	10,340	Not disclosed	Further test for subsequent manned vehicle; carried one dog, guinea pigs, black mice, insects, plants and seeds. Included radio and TV equipment relaying information on condition of animals from orbit.	19.995 Mc/s.	More than 100 min.	Storage batteries and solar cells.	Not disclosed	115	155	88.6	64.9	Baykonur (?); multi-stage booster.
										(Capsule recovered, believed after one orbit)				
Spacecraft V .. (Sputnik X)	Mar. 25, 1961	Cone-tipped cylinder (?)	10,330	Not disclosed	Repeat of Spacecraft IV experiment with one dog and other smaller test animals, plants, etc.	19.995 Mc/s.	More than 100 min.	Storage batteries and solar cells.	Not disclosed	111	150	88.4	64.54	Baykonur (?); multi-stage booster.
										(Capsule recovered, believed after one orbit)				
Explorer X ..	Mar. 25	Sphere 13 in. dia. joined to 19 in. dia. cylinder by tubular support.	79	Not disclosed	Gather data on Earth's and interplanetary magnetic fields and effect on these of solar plasma. Carried rubidium vapour magnetometer; two fluxgate magnetometers; plasma probe and optical aspect sensor.	108 Mc/s. at 35% efficiency and producing 5–6 W. of output power	60 hr.	Chemical batteries	Two sets 85 in. rods	100 (appx.)	145,000 (appx.)	112hr.	33	Cape Canaveral; Thor-Delta; launch weight 112,000 lb. (approx.).

Discoverer XIX	Dec. 20	As Discoverer XVI	2,100 (approx.)	Not disclosed	Systems evaluation of Agena B satellite; collect data on atmospheric phenomena and IR-radiation in Earth's atmosphere in support of programmes such as Midas.	Not disclosed	Ceased transmitting Dec. 25, 1960	Not disclosed	1 directional, 1 whip	[illegible]	[illegible]	[illegible]	[illegible]	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Samos II	Jan. 31	Cone-tipped cylinder 22 ft. × 5 ft. dia.	4,100 incl. second stage casing	Not disclosed	Same as Samos I.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	300 (appx.)	350 (appx.)	95 (appx.)	Near polar	Point Arguello; Atlas-Agena A; launch weight 273,000 lb. (approx.).
Sputnik VII	Feb. 4, 1961 (re-entered Feb. 26, 1961)	Not disclosed	14,292	Not disclosed	Establish heavy satellite in precise orbit; possibly control experiment for Sputnik VIII probe launcher.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	138.75	203.56	89.80	64	Baykonur (?); multi-stage booster.
Sputnik VIII (Venus probe)	Feb. 12, 1961 (Sputnik re-entered Feb. 25, 1961)	(a) Sputnik, not disclosed (b) Complex 80 in. long × 41 in. dia. with solar cell panels, etc.	(a) Not disclosed (b) 1,419	Not disclosed	Test of orientatable Sputnik as directional "launching platform" for Venus probe. Radio contact with latter lost on or about Feb. 27, 1961; Russians predicted that probe would pass within 62,500 miles of Venus between May 19–20, 1961.	(b) 922.8 Mc/s. on command	At least 97 days intermittent transmission intended	Storage batteries and solar cells in (b)	Omnidirectional 8 ft. long; 2 cross; parabolic directional "dish" over 6 ft. dia.	66.7 million (perihelion)	94.6 million (aphelion)	300 (days)	0.3 (to ecliptic)	Baykonur (?); multi-stage booster.
Explorer IX	Feb. 16	Sphere 12 ft. dia.	80 total incl. 15 lb. sphere and 65 lb. of ejection, inflation and telemetry equipment	Sphere of Mylar plastic film and aluminium foil	Same as Explorer for Dec. 4, 1960. Balloon transmitter failed to function properly.	136 Mc/s. at 15 Mw.	Not applicable	Miniature storage batteries and 280 solar cells	Two hemispheres aluminium foil	395	1,605	118.3	38.63	Wallops Island; Scout; launch weight 36,600 lb. (approx.).
Discoverer XX	Feb. 17, 1961	As Discoverer XVI	2,450 incl. second stage casing and 300 lb. re-entry capsule	Not disclosed	Systems evaluation of Agena B satellite—also modified stabilization system. Re-entry capsule carried four samples of silicon test materials for studying effect of high energy protons on silicon used in transistors and solar cells.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	177	486	95.4	80.43	Vandenberg A.F.B.; Thor-Agena B; launch weight 123,800 lb. (approx.).
										(Fault developed in satellite; no attempt to recover capsule)				
Discoverer XXI	Feb. 18	Cone-tipped cylinder 25 ft. long × 5 ft. dia.	Not disclosed	Not disclosed	Gather data on atmospheric phenomena and IR-radiation in atmosphere in support of U.S.A.F. early-warning satellite system, and test satellite stabilization and control. (Engine successfully re-started in orbit for first time.)	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	149	659	93.8 97.8 (after restart)	80.74	Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).
Transit IIIB and Lofti	Feb. 21, 1961	(a) Sphere 36 in. dia. (b) Sphere 20 in. dia.	(a) 250 (b) 57	As Transit IIIA	(a) Same as Transit IIIA; (b) measure intensity of VLF (Very Low Frequency) signals through ionosphere.	(a) 54.324, 162, 216 Mc/s.; SECOR: 224, 421, 448 Mc/s. (b) 136 Mc/s.	Indefinite	(a) and (b) nickel-cadmium storage batteries and solar cells.	(a) broad band spiral; (b) 4 rods.	117	511	94.5	28.36	Cape Canaveral; Thor-Able Star; launch weight 120,000 lb. (approx.).
										(Satellites failed to separate)				
Explorer ..	Feb. 24	Two truncated cones joined at bases 24 in. high × 30 in. dia.	74	Aluminium	Investigate shape of ionosphere by analysis of signals transmitted by satellite on six frequencies using 14 channels of information.	20.005, 40.010, 41,010, 108.02, 360.09; 960.24 Mc/s.	Not applicable	Nickel-cadmium storage batteries and solar cells.	Loop, 6 in. dia.	FAILED TO ORBIT (Third and fourth stages did not ignite)				Cape Canaveral; Juno II; launch weight 121,000 lb. (approx.).
Spacecraft IV .. (Sputnik IX)	Mar. 9, 1961	Cone-tipped cylinder (?)	10,340	Not disclosed	Further test for subsequent manned vehicle; carried one dog, guinea pigs, black mice, insects, plants and seeds. Included radio and TV equipment relaying information on condition of animals from orbit.	19.995 Mc/s.	More than 100 min.	Storage batteries and solar cells.	Not disclosed	115	155	88.6	64.9	Baykonur (?); multi-stage booster.
										(Capsule recovered, believed after one orbit)				
Spacecraft V .. (Sputnik X)	Mar. 25, 1961	Cone-tipped cylinder (?)	10,330	Not disclosed	Repeat of Spacecraft IV experiment with one dog and other smaller test animals, plants, etc.	19.995 Mc/s.	More than 100 min.	Storage batteries and solar cells.	Not disclosed	111	150	88.4	64.54	Baykonur (?); multi-stage booster.
										(Capsule recovered, believed after one orbit)				
Explorer X ..	Mar. 25	Sphere 13 in. dia. joined to 19 in. dia. cylinder by tubular support.	79	Not disclosed	Gather data on Earth's and interplanetary magnetic fields and effect on these of solar plasma. Carried rubidium vapour magnetometer; two fluxgate magnetometers; plasma probe and optical aspect sensor.	108 Mc/s. at 35% efficiency and producing 5–6 W. of output power	60 hr.	Chemical batteries	Two sets 85 in. rods	100 (appx.)	145,000 (appx.)	112hr.	33	Cape Canaveral; Thor-Delta; launch weight 112,000 lb. (approx.).

Name	Date	Shape and size	Weight	Shell material	Purpose	Radio				Orbit				Launching site and vehicle
						Frequency power	Lifetime	Power supply	Antennae	Perigee	Apogee	Period	Inclination to equator	
			lb.			Mc.				miles	miles	min.	deg.	
Discoverer XXII	Mar. 30 1961	As Discoverer XVI	As Discoverer XVI	Not disclosed	Systems evaluation of Agena B satellite; continue investigation of effect of cosmic rays on biological specimens, including some recovered from previous Discoverers. Also radiation experiments involving analine packs, glass needle dosimeters, emulsion plates, and X-ray films.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Unspecified mechanical fault.)				Vandenberg A.F.B., Thor-Agena B; launch weight 115,500 lb. (approx.).
Discoverer XXIII	April 8	As Discoverer XVI	As Discoverer XVI	Not disclosed	Systems evaluation of Agena B satellite with special reference to changed guidance, stabilizing and propulsion components to improve ability to control orbital period. Embodied high-intensity light beacons.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	†183 126	†388 982	†93.8 101.2	†82.31 81.94	Vandenberg A.F.B., Thor-Agena B; launch weight 115,500 lb. (approx.).
										(†Capsule ejected at wrong angle and remained in orbit.)				
Spacecraft VI Vostok I (Sputnik XI)	April 12	Cone-tipped cylinder	10,418	Not disclosed	First space-vehicle to carry man into orbit with successful recovery at end of first orbit. Astronaut: Major Yuri Gagarin. Landed Saratov region.	9.019, 20.006, 143.625, 19.995 Mc/s.	More than 100 min.	Chemical batteries and solar cells	Various loop	112.4	203	90	64.57	Baykonur; multi-stage booster with six engines developing 20,000,000 h.p.
										(Flight lasted 108 min.)				
Mercury-Atlas MA-3	April 25	Truncated cone topped by cylinder 9 ft. high × 6 ft. dia.	3,000 lb. plus	Titanium glass-fibre (shield)	First single-orbit test for unmanned Mercury capsule; contained crewman simulator and two playback tape recorders simulating voice communication.	Not available	Not applicable	Chemical batteries	Bicone	FAILED TO ORBIT (Atlas failed to follow programmed path after lift-off—destroyed by range safety officer but safe recovery of capsule via escape system.)				Cape Canaveral; Atlas-D; launch weight 260,000 lb. (approx.).
Explorer XI ..	April 27 (1–3 years)	"Street lamp" 23.5 in. long × 12 in. dia. octagonal box on 6 in. dia. 20.5 in. long column, with 44 in. long final stage.	82	Aluminium	Detect high-energy gamma rays from cosmic sources and map their distribution. Carried gamma ray telescope comprising a plastic scintillator, crystal layers and a Cerenkov detector; also Sun and Earth sensors, micrometeorite shield, temperature sensor and damping mechanism.	Two 107.97 Mc/s. at 125 mw.; 108.06 Mc/s. at 20–25 mm. for tracking	1 year	Nickel-cadmium batteries and solar cells	Loop and vehicle body	304	1,113.2	108.1	28.8	Cape Canaveral; Juno II; launch weight 121,000 lb. (approx.).
Explorer ..	May 24	Two truncated cones joined at bases 24 in. high × 30 in. dia.	75	Aluminium	Determine ionospheric electron content under quiet and disturbed conditions, study daily and seasonal variations and investigate radio wave propagation.	20.005, 40.010, 108.02, 360.09, 960.24, 41.010 mc/s.	Not applicable	Nickel-cadmium batteries and solar cells	Loop	FAILED TO ORBIT (Second stage did not ignite.)				Cape Canaveral; Juno II; launch weight 121,000 lb. (approx.).
Discoverer XXIV	June 8	As Discoverer XVI	As Discoverer XVI	Not disclosed	Same as Discoverer XXIII.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Second stage did not ignite.)				Vandenberg A.F.B.; Thor-Agena B, launch weight 115,000 lb. (approx.).
Discoverer XXV	June 16	As Discoverer XVI	As Discoverer XVI	Not disclosed	Same as Discoverer XXIV. Capsule contained rare and common metals for study of effects of exposure in space; also instruments to measure radiation and micrometeorite effects.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	139.1	251.6	90.87	82.11	Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
										(Capsule ejected and recovered from sea June 18, 1961.)				
Transit IVA, Greb III and Injun	June 29	(a) Polygon 31 in. long × 43 in. dia. (b) Sphere 20 in. dia. (c) Cylinder 13 in. long × 16 in. dia.	(a) 175 (b) 55 (c) 40	(a) Not available (b) Aluminium (c) Not available	(a) Same as Transit IIIA; but satellite of different configuration embodying 4.5 lb. nuclear generator fuelled with Plutonium 238; (b) measure solar X-rays; (c) measure cosmic ray intensity.	(a) 4 transmitters 54 and 320 Mc/s; (b) 1 transmitter; (c) 136.20 Mc/s.	(a) 1 year, (b) and (c) indefinite	Nuclear generator in (a), with solar cells nickel cadmium batteries throughout	(a) 12 rod (b) 4 rod (c) 4 rod	(a) 534 (b) and (c) 534	(a) 623 (b) and (c) 634	(a) 103.7 (b) and (c) 103.8	(a) 67 (b) and (c) 67	Cape Canaveral; Thor-Able Star, launch weight 120,000 lb. (approx.).
										(Greb III and Injun failed to separate.)				
Explorer ..	June 30	Cylindrical 76 in. long × 24 in. dia.	187	Various foils and stainless steel samples	Study performance of Scout booster; investigate nature of micrometeoroids. Final stage virtually covered by five types of detectors exposed to impact and penetration.	136.860 and 136.20 Mc/s.	Not applicable	Nickel-cadmium batteries and solar cells	4 rods	FAILED TO ORBIT (Third stage did not ignite.)				Wallops Island; Scout, launch weight 36,600 lb. (approx.).

* Excluding vehicles designed for sub-orbital missions.

Continued overleaf

RECORD OF ALL KNOWN SPACE-VEHICLE LAUNCHINGS *

(Continued from our issues of Aug. 28, 1959, and Aug. 12, 1960, and corrected to Sept. 17, 1961)

Continued from page 499

Name	Date	Shape and size	Weight	Shell material	Purpose	Radio				Orbit				Launching site and vehicle
						Frequency power	Lifetime	Power supply	Antennae	Perigee	Apogee	Period	Inclination to equator	
			lb.			Mc.				miles	miles	min.	deg.	
Discoverer XXIV	July 7	As Discoverer XVI	As Discoverer XVI	Not disclosed	Same as Discoverer XXIII.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	146 (Capsule ejected and snatched by C-119)	503	95	82.93	Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).
Tiros III	July 12	Cylinder 19 in. high × 42 in. dia.	285	Aluminium/ stainless steel	As Tiros II, but with both TV cameras wide-angle.	Two 235 Mc/s.; one 237.8 Mc/s.; two tracking beacons on 108 and 108.03 Mc/s.	Indefinite	Nickel-cadmium batteries and 9,260 solar cells	As Tiros II	461.02	506.44	100.4	47.8	Cape Canaveral; Thor-Delta, launch weight 112,000 lb. (approx.).
Midas III	July 12	Cone-tipped cylinder 30 ft. long × 5 ft. dia.	3,500 incl. second stage casing	Not disclosed	Overall test of system for detection of missile launchings with satellite-borne IR-sensors.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	2,129	2,153	161.5	91.2	Point Arguello; Atlas-Agena B, launch weight 263,500 lb. (approx.).
Discoverer XXVII	July 21	As Discoverer XVI	As Discoverer XVI	Not disclosed	Reliability testing of Agena B; improvement of orbital period control; ejection and recovery of capsule.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Launch vehicle veered from course; destroyed by range safety officer.)				Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).
Discoverer XXVIII	Aug. 3	As Discoverer XVI	As Discoverer XVI	Not disclosed	Carried equipment for testing modifications embodied as a result of deficiencies found in Discoverers XXV and XXVI.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	FAILED TO ORBIT (Final stage did not achieve orbital velocity.)				Vandenberg A.F.B.; Thor-Agena B; launch weight 115,500 lb. (approx.).
Spacecraft VII Vostok II (Sputnik XII)	Aug. 6	Cone-tipped cylinder (?)	10,432	Not disclosed	Similar to Vostok I, but with new type air regeneration system. Astronaut Gherman Titov made separate parachute recovery in ejector couch; spacecraft also landed safely.	As Spacecraft V1	Not disclosed	Not disclosed	Not disclosed	114 (Total flight time 25 hr. 18 min.; completed 17 orbits.)	152	88.46	64.56	Baykonur; multi-stage booster as for Vostok I.
Explorer XII	Aug. 15	Cone with octagonal base 19 in. high × 27 in. dia.	83	Not disclosed	Investigate solar wind, Earth's and interplanetary magnetic fields, energetic particles in space.	136.020 Mc/s.	Indefinite	Silver-cadmium batteries and 5,600 solar cells	4 rods	180	47,800	26 hr. 25 min.	33.3	Cape Canaveral; Thor-Delta, launch weight 112,000 lb.
Ranger I	Aug. 23	Complex 11 ft. long × 5 ft. base dia.	675	Not disclosed	Development of spacecraft system for future lunar and interplanetary missions. Object was to place Agena stage and payload in near-circular Earth orbit and launch Ranger spacecraft accurately on a deep-space orbit. Experiments in solar radiation, cosmic rays, solar X-rays, cosmic dust, etc.	¼W. transmitter on 960.1 Mc/s.; 3W. transmitter on 960.05 Mc/s.	Not applicable	Silver-zinc battery plus several smaller power systems, and 8,680 solar cells.	One directional "dish"	105.3 (Ranger separated from satellite carrier but not injected on departure trajectory.)	312.5	91.1	32.90	Cape Canaveral; Atlas-Agena B; launch weight 275,000 lb. (approx.).
Explorer XIII	Aug. 25	As Explorer June 30, 1961	As Explorer June 30, 1961	As Explorer June 30, 1961	Repeat experiment of Explorer, June 30, 1961, for study of micrometeoroids.	As Explorer June 30, 1961	As Explorer June 30, 1961	As Explorer June 30, 1961	As Explorer June 30, 1961	174.60 (Provisional figures—satellite re-entered within four days.)	606.34	97.27	36.42	Wallops Island; Scout, launch weight 36,600 lb. (approx.).
Discoverer XXIX	Aug. 30	As Discoverer XVI	As Discoverer XVI	Not disclosed	Continued testing of Agena B.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	140 (Capsule ejected on 33rd orbit and recovered from sea.)	345	91	82.14	Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).
Samos	Sept. 9	As Samos II	As Samos	Not disclosed	As Samos II.	Not disclosed	Not disclosed	Not disclosed	Not disclosed	FAILED TO ORBIT (Exploded on launch pad.)			Near polar	Point Arguello; Atlas-Agena B; launch weight 275,000 lb. (approx.).
Discoverer XXX	Sept. 12	As Discoverer XVI	As Discoverer XVI	Not disclosed	Continued reliability testing of Agena B, etc.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	154 (Capsule ejected on 33rd orbit and air-snatched by JC-130B.	345	92.4	Near polar	Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).
Mercury-Atlas MA-4	Sept. 13	As Mercury-Atlas MA-3	As Mercury-Atlas MA-3	As Mercury-Atlas MA-3	Repeat launching of Mercury-Atlas MA-3 capsule. Carried crewman simulator.	As Mercury MA-3				99 (Capsule recovered from sea after one orbit; total flight time 110 min.)	144	See below	AsMA-3	Cape Canaveral; Atlas-D, launch weight 260,000 lb. (approx.).
Discoverer XXXI	Sept. 17	As Discoverer XVI	As Discoverer XVI	Not disclosed	Continued reliability testing of Agena B, etc.	Not disclosed	Not disclosed	Not disclosed	1 directional, 1 whip	(Orbit achieved; capsule failed to separate.)			Near polar	Vandenberg A.F.B.; Thor-Agena B, launch weight 115,500 lb. (approx.).

* Excluding vehicles designed for sub-orbital missions.

Missile and Satellite Review . . . .

TABLE 4
DEVELOPMENT TRENDS

Class of missile	Description	Typical dimensions			Typical performance		Type of motor generally used	Normal method of control	Normal type of guidance
		Length (ft.)	Body dia. (ft.)	Weight (in tons)	Range (n.m.)	Speed Mach No.			
Strategic SSM	ICBM—Very long-range ballistic ..	80	10	100	5,500	25	Liquid-fuel rocket	Gimballed motors	Inertial
	LRBM—Long range ballistic (IRBM)	60	9	60	2,000	20	Liquid-fuel rocket	Gimballed motors	Inertial
	Pilotless long-range bomber ..	50	4	10	5,000	0.9	Turbojet	Aircraft-type aero-foils	Hybrid inertial
Tactical SSM..	MRBM—Medium range ballistic ..	45	6	20	150	4	Solid-fuel rocket	Deflection of thrust	Inertial
	Short-range missile	20	2	1	10	0.9	Solid-fuel rocket	Fins aft	Radio command
	Short range ballistic	25	3	3	10	2	Solid-fuel rocket	Deflection of thrust or spinning	Spin stabilized
	Field of battle, anti-tank	6	½	0.1	2	0.5	Solid-fuel rocket	Deflection of thrust or fins aft	Visual, wire link
	Field of battle, infantry	4	½	0.015	1	0.3	Solid-fuel rocket	Fins or spoilers aft	Visual, wire link
Strategic ASM	Stand-off bomb, medium range ..	35	4	7	300	1.5	Turbojet ..	Fins forward ..	Inertial
Tactical ..	Powered bomb, short range ..	10	1	0.5	10	1	Solid-fuel rocket	Fins forward ..	Visual, radio link
SAM	ABM—Anti-ballistic missile.. ..	30	4	5	200	7	Solid-fuel rocket	Fins forward or aft	Radio command
	Area defence, semi aircraft	50	3	7	250	3	Ramjet	Aircraft-type aero-foils	Active
	Medium range	25	2	1.5	60	2.5	Ramjet	Wing steering ..	Semi-active.
	Short range	20	1½	0.7	20	2	Solid-fuel rocket	Fins forward or aft	Semi-active
	Field of battle	6	½	0.02	4	0.3	Solid-fuel rocket	Fins aft	Visual, radio link
AAM ..	Short range and field of battle ..	10	½	0.2	5	2	Solid-fuel rocket	Fins forward or aft	Infra-red

(*Continued from page 492*)

In general, a missile is designed to alter course at some multiple of the rate at which the line of sight is altering; this amount is known as the K factor. If the K factor is 1, it means that the missile alters course as fast as the line of sight alters. If it starts with its nose pointing at the target, it will, therefore, keep its nose on the target and achieve a "curve of pursuit," as shown in Fig. 14A. This is, of course, an uneconomical form of interception which tends towards a stern chase and so may fail altogether unless the missile has a considerable speed margin over its victim.

If the K factor is very large, it means that for a very small change in direction of the line of sight, the missile will make a very large alteration of course which will immediately cancel out this change of direction. As a result, the direction of the target will not, in theory, change and the missile will achieve a line of constant bearing interception. This is, of course, the ideal.

It is quite evident, however, that if K is very large the slightest change in target line of sight will result in a large change of missile heading and over-correction is bound to follow, as shown in Fig. 14B. Therefore, in practice, a compromise is necessary and a figure is chosen which gives a better interception than a curve of pursuit but is not so unstable as a line of constant bearing, as suggested in Fig. 14C.

It is now evident why line-of-sight gyroscopes are such important items in semi-active or active homing systems. Not only do they stabilize the dishes, but they also provide the information on which the interception can be based.

Fig. 14a.

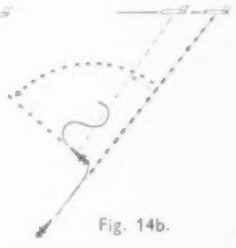


Fig. 14b.

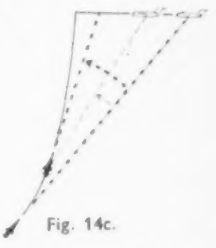


Fig. 14c.

Vision in Astronautics

SPEAKING at the opening session of the I.A.F. Congress in Washington on Oct. 2, Dr. Hugh L. Dryden, deputy administrator of NASA, laid stress on the need for global co-operation in astronautics. We reproduce below a large portion of his interesting paper.

As the astronomers continually remind us, the exploration of space began centuries ago with the human eye as the sole instrument. Observed regularities in the apparent motions of the stars gave rise to the early clocks and almanacs. As science developed, new methods of measurement and more and more refined measuring instruments were developed. From the light and other electromagnetic radiation penetrating the Earth's atmosphere, astronomers through the centuries have gained a tremendous amount of knowledge about the size, distance, motion, chemical composition, temperature and other physical properties of the celestial bodies.

Today, following the pioneering work of Tsiokovskii, Oberth and Goddard and the more recent large-scale development of rockets for military purposes, Man has at his disposal the means of sending instruments far out into space and of venturing himself for short distances to explore and to discover and to learn. In four years we have made a modest beginning and the pathway ahead is one to be followed by men of vision, courage and faith.

The word "exploration" brings to mind the great voyages of discovery of Columbus and Magellan over the broad oceans and of Peary and Scott across the forbidding icy wastes of the polar regions. For ages the explorer has been restricted to the surface of the Earth. But in the 18th century he left the Earth's surface for the first time in a hot air balloon, soon rising to heights of a few miles. Then on Dec. 17, 1903, centuries after the first legends of human flight, Man left the surface in controlled flight in a relatively fragile vehicle of wood, wire and cloth.

Exploration of space by unmanned vehicles began on Oct. 4, 1957, when the first artificial satellite of the Earth, a Man-made moon, was launched into orbit. So far Man has sent no less than 65 such artificial moons into orbit around the Earth and four in orbit about the Sun. The total weight of these objects is more than 75 tons, not much compared with the weight of the Moon, but an impressive beginning.

The International Astronautical Federation was founded in 1950. Article I of its first constitution stated that "the I.A.F. shall exist to promote and stimulate the achievement of space-flight as a peaceful project." The exploration of space by Man is geographical exploration on a grand scale, if we may expand the meaning of the term "geographical."

Our nearest neighbour, the Moon, is about 240,000 miles away, or roughly 10 times the circumference of the Earth. Venus is at a distance of about 1,100 times the Earth's circumference. The first steps in accomplishing the first aim of the I.A.F. have been taken and the necessity of continuing manned exploration is widely recognized.

Thus in a recent policy statement the Space Science Board of the National Academy of Sciences strongly emphasized that "planning for scientific exploration of the Moon and planets

must at once be developed on the premise that Man will participate. Man can contribute critical elements of scientific judgment and discrimination in conducting the scientific exploration of these bodies which can never be fully supplied by his instruments, however complex and sophisticated they may become."

The proposed new draft of the I.A.F. constitution lists as the first objective: "To advance the development of astronautics for peaceful purposes." This change gives recognition to the manner in which astronautics has actually developed in its first four years. In addition to activities in the manned exploration of space, much progress has been made in space science and technology and their application to practical use in weather, communication and navigation satellites as well as to the support of spaceflight by Man. The diversity of the titles of the papers included in the programme of this Congress illustrates the broad interests of the members of the Federation.

Research Progress

Great strides have been made in space science. Although this field is of primary interest to the Committee on Space Research of the International Council of Scientific Unions and to several of the individual international unions, the Federation has an interest in the results in relation to technology and the design of spacecraft for specific purposes. The principal goals of space science are to investigate the Earth and its atmosphere and the influence of the Sun upon the Earth; to study and understand the nature and history of the Earth, the Moon, the remainder of the Solar System, and the universe; and to search for the presence of life outside the Earth.

The principal peaceful use, in addition to scientific investigation, which has advanced greatly during the first four years, is the application of weather satellites to global cloud observation and weather forecasting. During the week of Nov. 13, the representatives of the meteorological services of more than 25 nations will assemble to participate in a workshop, in which these weathermen will observe the reception of cloud photographs from the current weather satellite, if it is still performing satisfactorily. They will be given practical training in the interpretation of the photographs, so that on returning home they will be able to make effective use of data transmitted to them in day-to-day forecasting. The use of satellites for world-wide communication looks equally promising.

The I.A.F. constitution lists four additional aims which are worthy of emphasis and comment in connection with the Congress. They may be summarized as: (1) Widespread dissemination of technical and other information; (2) stimulation of public interest and support; (3) encouragement of participation in research by international and national agencies and individuals; and (4) co-operation with international and national agencies on all aspects of the natural and social sciences related to astronautics and the peaceful uses of outer space.

This Congress is a key factor in the prompt and widespread dissemination of information on astronautics to leading scientists, engineers, and other professionals of the World. This process will be effective to the extent that space activities are carried on in the open and the results shared with the World community. Scientists and engineers need complete and detailed quantitative reporting. The interplay of free analysis and discussion by the leading research workers of the World leads to more rapid progress in every country because new results may appear anywhere within the tremendous range and scope of scientific and engineering knowledge underlying the exploration of space.

International Co-operation

Space exploration has advanced from the realm of fantasy and dream through the stage of discussion of conceptual schemes to a demonstration of technical feasibility. The greatest needs of the immediate future are the stimulation of widespread public support nationally and internationally and the achievement of co-operative efforts on a global scale.

Widespread public support requires a major effort from all of us to interpret to people of many backgrounds not only the "how" but also the "why" of space exploration. To describe our objective merely in terms of a technical task, i.e., to send a three-man expedition to explore the Moon, fails to secure the support of many.

We must explain again and again the rôle in a scientific and technological age of an activity which catalyzes and integrates the expansion of the frontiers of knowledge. The real values lie in the major development, in science and technology applicable to what Man will do in space rather than in the mere accomplishment of Man setting foot on the Moon.

The large sums of money required in this effort are not spent in outer space or on the Moon; they are spent in the factories, workshops and laboratories for salaries, materials and supplies. The new knowledge and experience are transferable to other areas of industry, as in the past in the development of the automobile, aeroplane and nuclear reactor.

Education will profit. Society will gain through the discipline of co-operation in a major task. We must convince the public that the exploration of space is an activity of critical importance for the future of science, industry, education and public welfare in every nation, and that funds so spent will return benefits manyfold. Perhaps the lessons of the history of aeronautics may help.

Finally, a major goal of the I.A.F. is international co-operation in astronautics. Perhaps the most significant development in the first four years of the Space Age is the growth of international co-operation in space exploration on a wide scale. In an international programme, under the Committee on Space Research of ICSU, the first two co-operative satellite launchings will take place in the first half of 1962 and others will follow. At the last Congress in Stockholm a symposium on small sounding rockets revealed the interest in, and possibilities of, sounding rocket programmes as the first step in space exploration for many countries, singly or in concert, who could not as yet engage in satellite programmes.

As already mentioned, many countries are co-operating in weather research associated with satellite observations and several are preparing to co-operate in studies of communication via the active communication satellites to be launched next year. Nineteen countries are engaged in co-operative tracking and data recording from satellites and space probes. There are growing activities in the exchange and training of personnel. International co-operation in the exploration of space does contribute to friendship and understanding among nations and substantive scientific contributions come from the participants.

The I.A.F. is an association of organizations, each of which is represented in the General Assembly. Within the I.A.F. there has been established the International Academy of Astronautics and an International Institute of Space Law. These bodies are composed of elected individual members and engage in meetings and colloquia on specialized topics, the making of awards and publications.

Concluding his address Dr. Dryden said, "I would emphasize the major importance of the rôle of the talented individual of vision who may come from any race or country. Every accomplishment of the human race must be preceded by the vision of that accomplishment in the mind of some individual.

"Many of you have read Irving Stone's 'The Agony and the Ecstasy,' a novel of Michelangelo, the sculptor. Before the rough lumps of marble can be transformed under the tools of the sculptor to reveal the forms imprisoned within it, the sculptor must see these forms with his mind's eye. So, too, with space exploration.

"Though finally implemented and realized by a large and highly competent group of men, each worth-while accomplishment is first a vision in the mind of some one man. The exploration of space requires many such men of vision to be identified and supported in the many nations here represented, so that we may proceed from vision to accomplishment."

Major Titov on Film

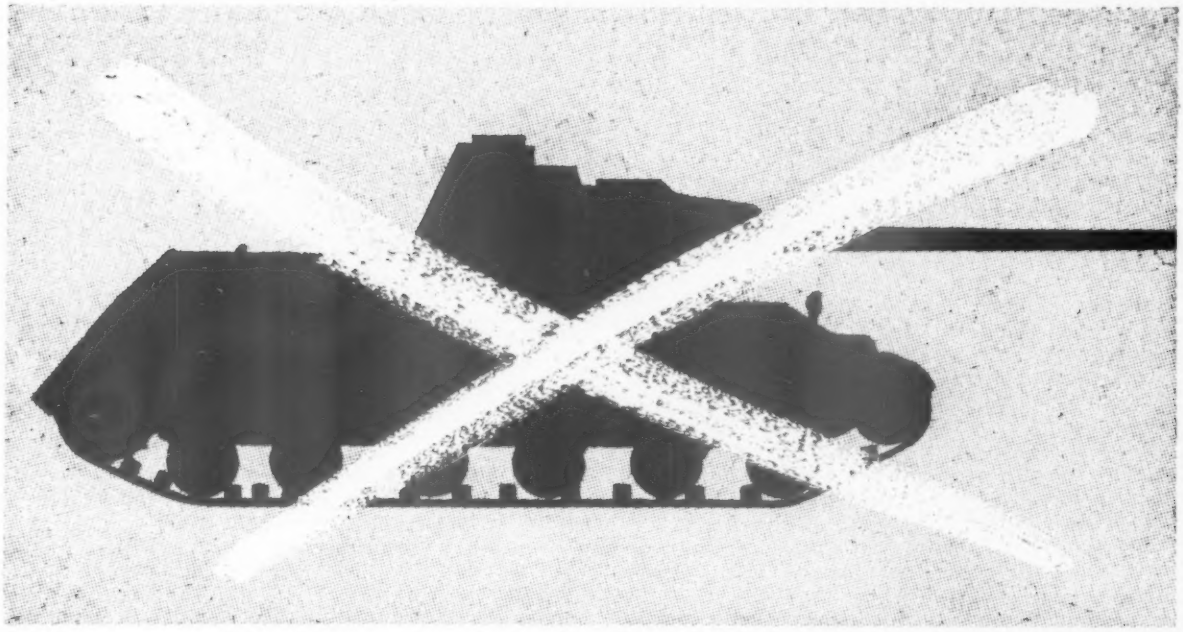
FOLLOWING the colour documentary film, shown in this country under the title "With Gagarin to the Stars," the Moscow Popular Science Film Studios have produced the inevitable sequel, "Towards the Stars Again," depicting the 25-hr. 18-min. mission of Major Gherman Titov on Aug. 6-7. The film has not yet been seen in this country, but *Soviet News* gives the following account of its contents.

"The film was shot where the flight was actually prepared and carried out—on the training stands and the cosmodrome. Wide use is made of the unique photographs taken by Titov during his flight.

"The work of the Co-ordinating Computing Centre and the launching team at the cosmodrome and the preparation of the carrier rocket for the launching and its ascent are shown on the screen for the first time.

"Apart from sequences showing Titov undergoing training on the centrifuge, in which he is rotated at tremendous speeds in three planes, there are shots of the cabin of Vostok II and of Titov putting on his space suit and being taken, together with cosmonaut three, to the launching pad. The film also shows the spaceship taking off and Titov landing by parachute."

Following the inconsistencies apparent in the film of Major Gagarin's mission in Vostok I (THE AEROPLANE AND ASTRONAUTICS, Aug. 24, 1961, p. 214), we can only hope that a less heavily censored account of Major Titov's flight has been possible.—K.W.G.



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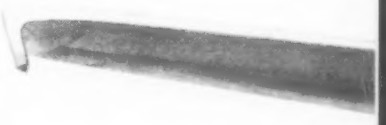

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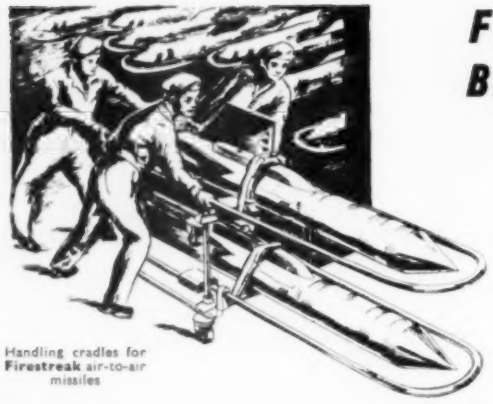

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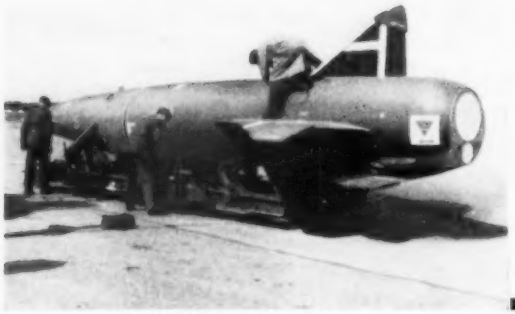

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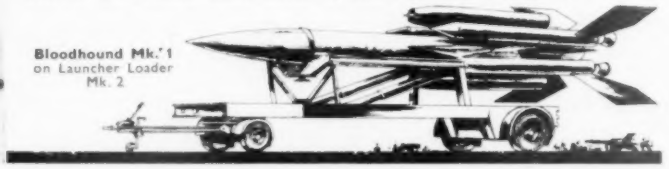

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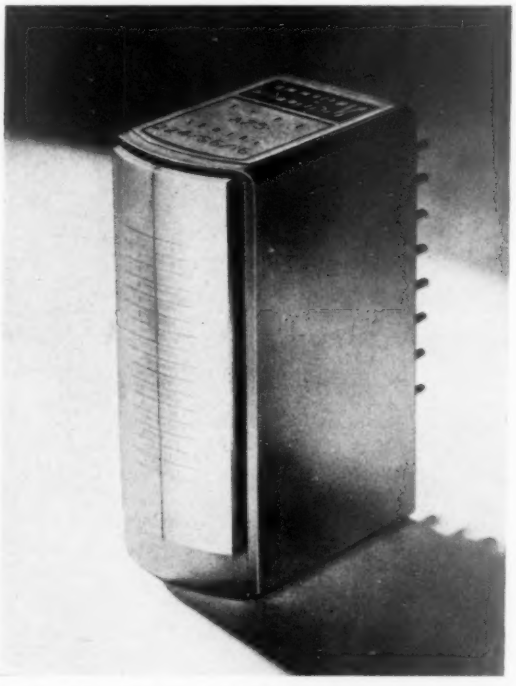

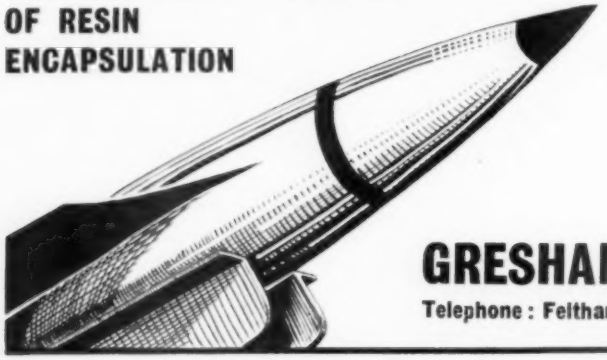

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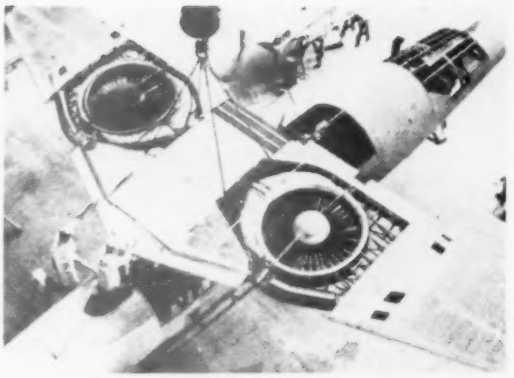
Aviation News in General (continued)

SIDEWINDER SABRES. — F-86K Sabres operated by three Royal Netherlands Air Force squadrons, Nos. 700, 701 and 702, have been modified to carry two Sidewinder AAMs. This has resulted in a 2-ft. increase in wingspan. When the squadrons re-equip with F-104Gs the Sabres are to go to the Turkish Air Force.

RAVEN ORDER. — More H-23D Raven light observation helicopters—a figure of 200 has been quoted—are to be procured by the U.S. Army under a $6,639,880 contract awarded to Hiller. This order is an interim measure to fill the Army's requirement until one of the three T63-powered designs, now under evaluation, is selected for production. Several hundred H-23Ds are already in use.

F-104G DE-ICING.—The Pacific Airmotive Corpn., Spraymat licencees in the U.S., are to supply the electrical de-icing system for engine inlet ducts on the Super Starfighters being built for Italy, West Germany and the Netherlands. The company is also providing a similar service for Lockheed and Canadair-built F-104s.

GULFSTREAM ACROSS.—National Distillers' Grumman Gulfstream executive aircraft flew non-stop across the Atlantic from Gander to Gatwick last week with the aid of its new wing tanks. These extend the range from 2,500 to 2,940 st. miles and the Gulfstream was still able to carry a party of 10 persons, including the pilots. The Gulfstream is embarking on a European tour on behalf of the National Distillers company.



VTOL RESEARCH.—The wings of the full-scale fan-in-wing wind-tunnel model developed under a joint U.S. Army-General Electric-NASA programme are mated with the fuselage before the start of another series of tests intended as the final step before a lift-fan flight-test programme.

BEECH PROJECT.—Beech Aircraft Corp. aims to begin delivery during 1964 of a twin-turboprop, 6/8-seat executive low-wing aircraft, cruising at 300 m.p.h. with a 1,500-mile range. It will have a pressurized cabin.

AIRLINE HELICOPTER.—Sikorksy S-65 is the designation of an airline version of the S-64 flying crane, using the same powerplant, rotor and transmission system, and a fuselage for 60 passengers. The company is briefing selected U.S. airlines on the project.

FOR V.I.P. MOVEMENT.—The Luftwaffe is to acquire two DC-6Bs for use as V.I.P. transports. They will be based on Köln-Bonn Airport.

SPUTNIK TV.—Konstantin Sergeichuk, U.S.S.R. Deputy Minister of Communications, states in the weekly newspaper *Ekonimicheskaya Gazeta*, that serious attention should be paid to the use of satellites for broadcasting television. The multi-national composition of Russia's population, he writes, makes it necessary to solve the problem of broadcasting the sound accompanying the television signals in a number of languages.

FLUID ABSORBER.—The ejectable "rough-landing" lunar capsule, to be carried by the Ranger Moon-probe, will be 25 in. in diameter and have a 12-in. ball of instruments floating inside in liquid. It will detach from the parent spacecraft when 20-25 miles from the Moon; a retro-rocket will reduce speed to about 150 m.p.h. for the landing.

SUB. HUNTER.—The first of 15 P2V-7B Neptunes for the Royal Netherlands Navy climbs away from the Lockheed-California Company's Burbank airfield. Twelve P2V-7s, the last to be built, are also being manufactured for the R.A.A.F. Production of the Neptune began in 1944.

Commercial Aviation Affairs (continued)

FEDERAL AVIATION SERVICE.—The F.A.A. has proposed the creation of a Federal Aviation Service to handle air traffic control and other essential air services in time of national emergency. Basically it would comprise civilian employees of the F.A.A. who could be transferred to military status at short notice.

EXTENSION IN ROME.—A third runway is to be laid at Fiumicino Airport, parallel to the existing 12,800 ft. 16R : 34L runway. The 07 : 25 runway is to be extended from 7,750 ft. to approximately 10,000 ft.

B.U.A. TO TENERIFE.—A weekly Viscount service between Gatwick and Tenerife in the Canary Islands was inaugurated on Oct. 7 by B.U.A. It will operate as an all tourist service and is in addition to B.U.A.'s daily flight to Las Palmas.

COSTLY GROUND AID.—A Canadian VORTAC station to be installed at 7,000 ft. on the Edmonton-Vancouver airway is being housed in a concrete structure which will be buried in the top of a mountain. Siting of VOR calls for a flat, circular, unobstructed platform 300 ft. in diameter and the Canadian Department of Transport has found it more practical to remove the top of the mountain and to bury the station.

SAFETY SEMINAR. — The Flight Safety Foundation will hold its 14th annual international air safety seminar on Nov. 13-16 in Naples, Italy. The theme will be "International Co-operation in Air Safety."

JUGOSLAV CARRIER.—The existence of a new air transport operator in Jugoslavia has been confirmed with the sale of four DC-6Bs to Adria Aviopromet, of Lubliana, by K.L.M.

LEEDS/BRADFORD PAUSE.—Implementation of the £2 million development plans for Leeds/Bradford Airport, including extension of the main runway to 6,700 ft., has been postponed. The Airport Joint Committee decided to seek assurances of financial help from the Ministry of Aviation.

U.A.A. COMET RECORD.—Figures published by United Arab Airlines for the first 12 months of operations with their Comet fleet show an achieved regularity of 99.3% and an average daily utilization of 6.05 hrs. The weight load factor achieved was 44.47% and the passenger load factor was 42%.

CARGO SYMPOSIUM.—Next year's IATA technical conference, starting on April 30, will be a special symposium on air cargo to be held at Lucerne, Switzerland.

GHANA TRAINING.—Five more Ghanaians have been selected by Ghana Airways for training as pilots. They will train with the Ghana Air Force at Takoradi; six Ghanaians are at present being trained in the U.K. and one in Egypt.

SUPPRESSOR SPEED BOOST.—T.W.A. is changing the noise suppressors on its 15 Boeing 707-120s from the original 21-tube type to the newer nine-tube "daisy" type. Lower drag and higher efficiency of the new design gives a nine m.p.h. speed increase.

Personal Flying

The PD-808 Executive Jet

LATEST news of the joint Piaggio-Douglas twin-jet executive project, the PD-808, is that it is scheduled for flight testing towards the end of next year and for delivery in 1963. The PD-808, which will have accommodation for 6-10 persons, has been designed by Douglas and will be manufactured by the Italian Piaggio company under an agreement concluded earlier this year.

Powered by two rear-mounted General Electric CJ610-1 of 2,850 lb. thrust each, or two 3,000 lb. Bristol Siddeley Viper 20s, the PD-808 will cruise at over 500 m.p.h. at ranges of up to 1,500 miles. In its executive version, it will have a max. take-off weight of 15,000 lb. and a landing weight of 14,300 lb., with a 2,000 lb. payload.

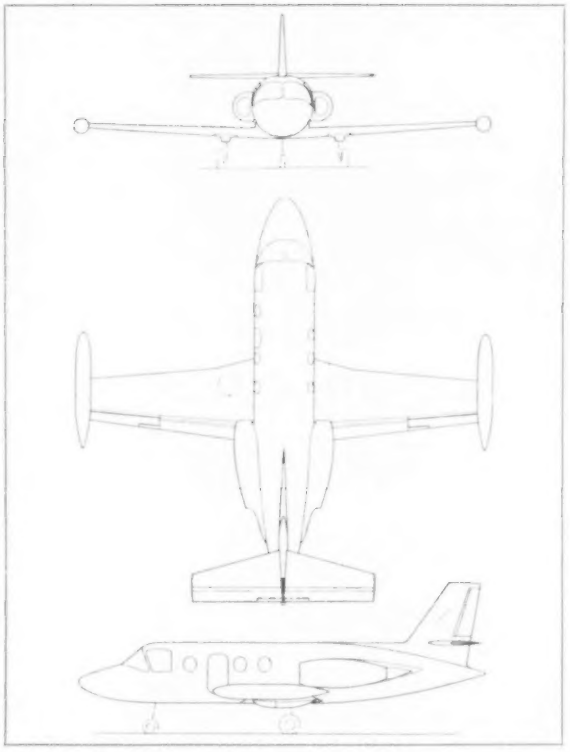
In its arrangement with Piaggio, Douglas plans to sell and service the PD-808 throughout most of the World. The agreement also envisages future manufacture in the U.S. by Douglas under certain conditions. An extensive three-year market survey forecast a market for several hundred aircraft of the PD-808 type during the current decade.

Leading particulars of the PD-808 are:—

Dimensions.—Span, including tip-tanks, 40.67 ft.; length, 39.5 ft.; height, 14.5 ft.; wing area, 225 sq. ft.

Weights.—Empty, 7,527 lb.; maximum payload, 2,000 lb.; intermediate flight gross weight (60% fuel), 12,293 lb.; max. take-off weight, 15,000 lb. Fuel, including tip-tanks, 5,428 lb. (835 U.S. gal.).

Performance.—Max. cruise speed at 40,000 ft., 520 m.p.h.; initial climb, 7,440 ft./min.; stalling speed, power off, at landing gross weight, 91 m.p.h.; approach speed, 119 m.p.h.; F.A.A. field length, 3,900 ft.; service ceiling, 46,500 ft.; single-engined ceiling, 29,000 ft.; single-engine climb, 2,375 ft./min.; max. flight duration, 4 hours.



Gliding Notes

by Dr. A. E. Slater

WHAT is a meteotron? MM. Henri and Jean Dessens, of Puy-de-Dôme observatory, told a Canberra conference on cloud physics that it is an apparatus for creating artificial thermals, and consists of "two pumps driving one ton of fuel oil per minute to 100 burners sited over an area 130 yards square," to quote *The Times* correspondent. The scene of operation is on the Plateau de Lannemezan, 12 miles north of the Pyrenees. What a pity they did not set up their meteotron at a gliding site!

In fair weather, only 15 burners need be lit to produce a cumulus cloud, the heat being equivalent to about 100,000 kilowatts. The cloud appears in six to eight minutes. So the rich man who rolls up to his high-class gliding club and orders his own private thermal complete with cumulus, as postulated by certain gliding prophets, would have to buy about a ton of fuel.

When all 100 burners are lit, the result is "a small artificial tornado."

* * *

BIRDS which soared in front of a thunderstorm and along sea-breeze fronts in search of insects were mentioned in these Notes for Sept. 28. Now comes a story from South Australia of a spiny-tailed swift, a bird which nests in Japan, being seen by E. R. Barratt, of Waikerie Gliding Club, while flying during a hot spell in the last Australian summer. He told the *Adelaide Advertiser* that hundreds of these birds had made their way to Australia by soaring in front of "monsoonal fronts," meanwhile feeding on the insects lifted in the upcurrents.

A chart of mean winds in the southern summer does indeed show a curved flow from Japan across northern Australia, but there it is stopped by a convergence zone, and a big departure from normal would be needed to convey a spiny-tailed swift farther south to Adelaide.

* * *

COLD fronts were at one time thought to be essential for setting up World's distance records, mainly because Günter Groenhoff's 169-mile record of 1931 remained unbeaten for three years. But for a cold front to persist for so long without gross changes of form must be unusual, yet one has been used by a New Zealand pilot to cover 193 miles along South Island for his Gold "C" distance leg.

Warren Denton, writing in the latest issue of *The Gliding Kiwi* about his "Gold Front," says that the day began with the usual wave cloud along the lee of the Southern Alps in a N.W. wind; but the Met. Office reported a vigorous cold front coming very fast from the south. It had already reached Timaru, 60 miles away, so he got into the Weihe and was towed towards it by a Tiger Moth owned by Gerald Westrena, who had already soared the Tiger with engine stopped in a similar front a few days before.

Arrived at the front, the cable was released at 3,900 ft. Westrena promptly shut off his motor and soared his Tiger back home in the lift, taking 40 minutes to do so. Denton in the Weihe thought the lift was nearer the frontal clouds than it actually was, and lost height rapidly until at last he located the upcurrent zone two miles in advance of the cloud belt, and rose to 6,500 ft. He again got behind into a downdraught, then pushed up his airspeed to 60 m.p.h. and reached North Canterbury 10 miles ahead of the squall line; so he waited in thermals for the front to catch him up, and reached his maximum height, 7,800 ft.

Banks Peninsula, which sticks out 30 miles into the Pacific with Christchurch at its root, held up the front for a time, but it seems to have leap-frogged this obstruction, for Denton had to dash on up the coast to where the Kaikoura mountain range runs close to the sea, so as to get there before the frontal clouds closed in and cut him off. He covered the next 60 miles in 45 minutes with 60 m.p.h. airspeed and a 35 m.p.h. wind behind his starboard wing, at about 5,500 ft.

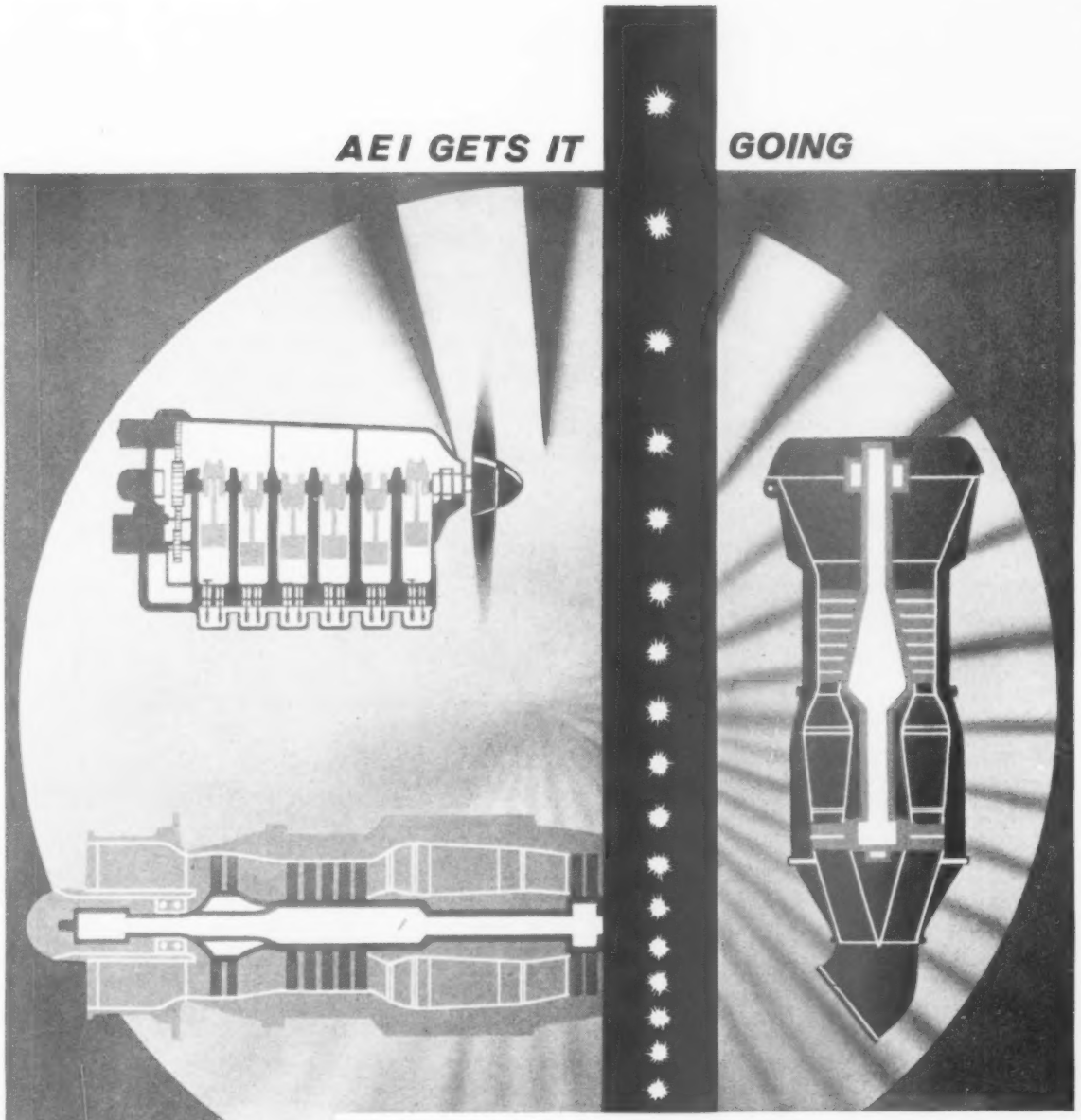
The south face of the Kaikoura provided terrific lift—2,000 ft. per mile, but he was again behind the front, and chased it inland. But it was weakening, and he finally landed at Seddon Township after covering 193 miles in 4 hr. 45 min.

* * *

TWO Russian national records for speed round a 200-km. triangle are announced by *Soviet News* Press service. Mikhail Veretennikov of Dniepropetrovsk, who already holds the international records for goal flight and 100-km., went round the 200-km. course in a single-seater at 89.563 km. (55.652 miles) per hr., and Vyacheslav Yefimov of Kiev did it in a two-seater at 80.924 km. (50.284 miles) per hr. International records are respectively 66.98 m.p.h. (R. E. Schreder, U.S.A.) and 50.64 m.p.h. (H. C. Ross, U.S.A.), and British records 49 m.p.h. (Anne Burns) and 27.5 m.p.h. (Tony Gaze).

Both records were put up on the same day from Moscow, but the date is not given, nor the sailplane type.

AEI GETS IT GOING



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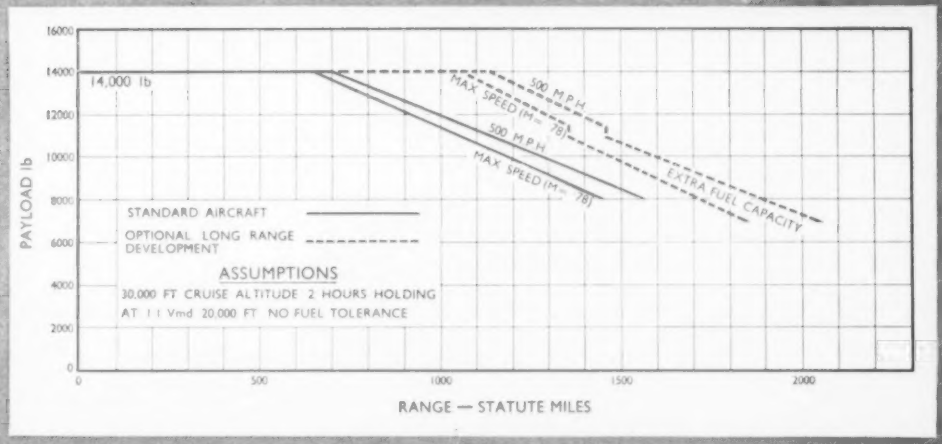
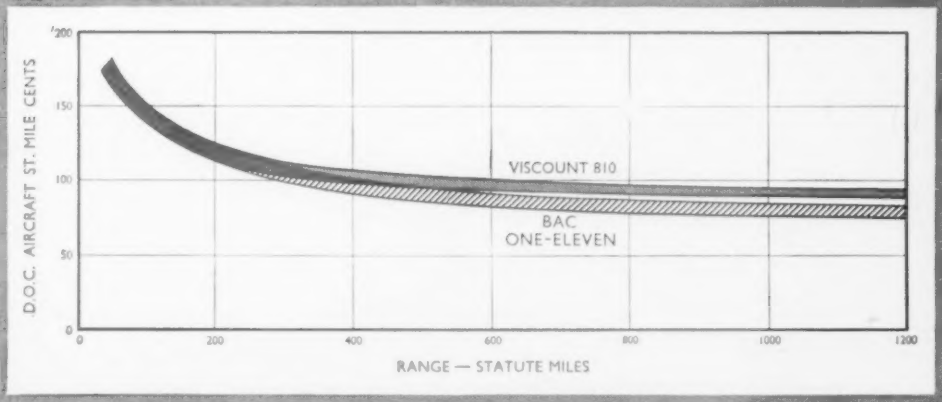


ECONOMICS

These bands cover seven separate methods of costing —ATA (1955), ATA (1960), SBAC and those of four airlines



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MARK 2

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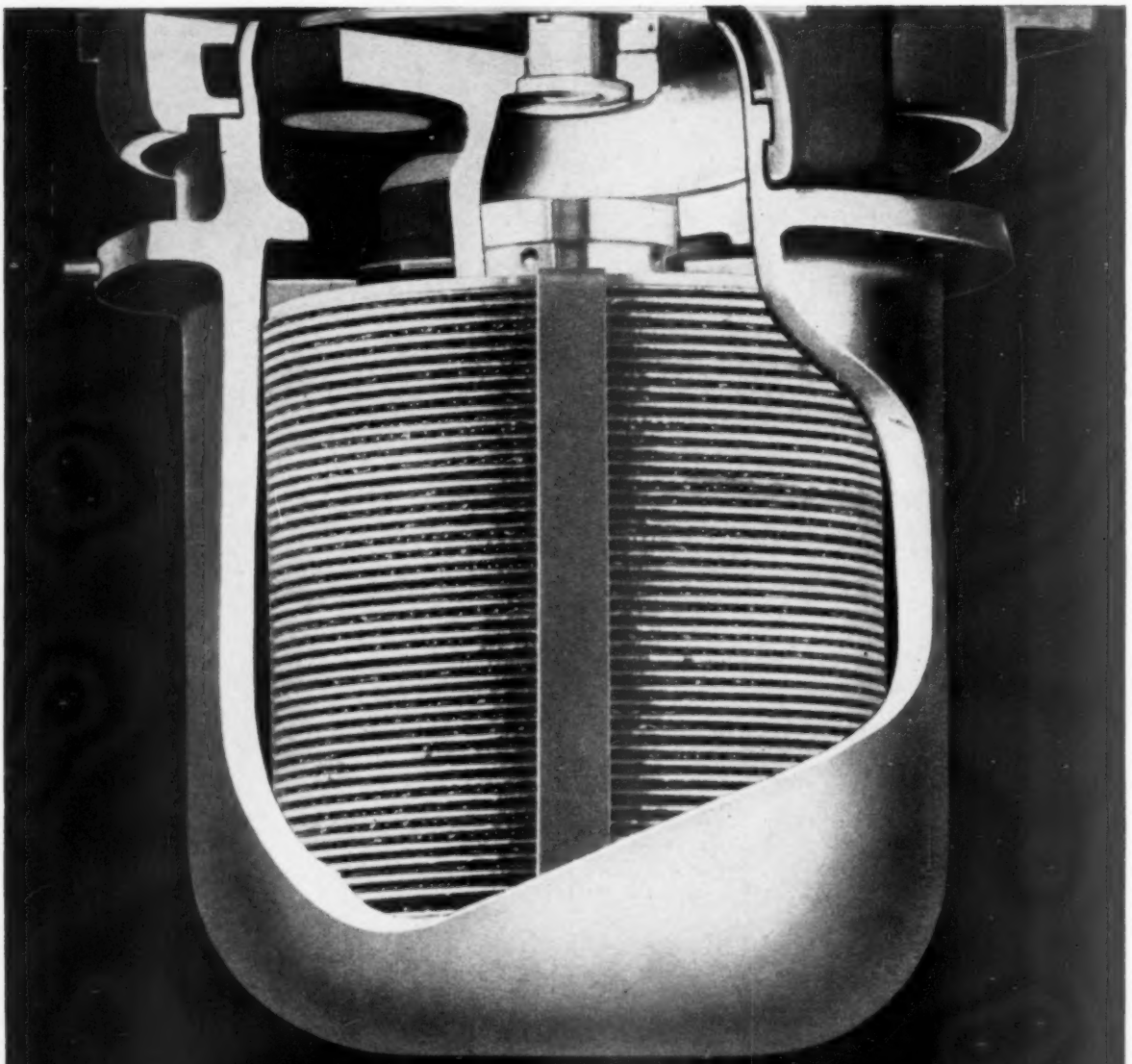

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Correspondence

Fifty Years of the Aero Engine

IN his article "Fifty Years of the Aero Engine" (June 8 last), the author makes no mention of the engine of Robert Esnault Pelterie, inventor of the stick, or control lever.

The Rhône and Clerget were radials.

No mention whatsoever is made of the work done by Sunbeam during the same period, 1914-18.

As to the progenitor of revolution?

Absolutely no mention is made of the pioneering work of the French engineers Armengaud and Lemale, 1904, who designed and built the first internal combustion turbine, without having any background, that kept running without any external assistance.

Whittle, or any other aero-engine designers, should have taken a lesson from the Hungarian engineer Jandrassik, who designed and built an industrial combustion turbine in 1913, with an axial compressor, similar to those currently produced.

As to the exhaust-driven turbo-supercharger, proposed by Rateau and Dr. Moss, if they had been further developed, the materials of the internal combustion turbine would have been much further advanced.

Thanks to the turbo-charger, two- and four-cycle oil engines are boosted to over 100%.

The author does not mention the experimental prototype of all by-pass engines, the turbo-jet fan of Metropolitan-Vickers, F-3, but condemns in their favour all prop-jets.

I apologize for pointing out certain omissions, voluntary or not, to show the evolution of the aero engine during the past half-century.

Paris XV. L. KEULEYAN.

The author of the article, Air Cdre. F. R. Banks, comments:—

I was most interested in Mr. Keuleyan's letter regarding the apparent omissions in the article I wrote for your Golden Jubilee issue. It is true that I did not mention the control system of Robert Esnault Pelterie, since this is purely an aircraft matter and has nothing to do with engines.

In the case of other pioneers and engines mentioned in Mr. Keuleyan's letter, I can only say that one cannot deal comprehensively with the history of this subject within 3,000 words.

While I regret these omissions, I felt history was served by mentioning only those engines that were practically responsible for getting the aeroplane into the air and contributing to its progress.

No. 43 Squadron

I HAVE recently been carrying out a little research into the history of No. 43 Squadron and wonder if any ex-members, or your readers, could add to my knowledge.

No. 43 Squadron had a fair proportion of exceptional pilots in both Wars, and I would like to know a little more about, in particular, C. F. King, H. W. Woollett and J. L. Trollop. King, unfortunately, was killed at Sedgeford on Jan. 24, 1919, but H. W. Woollett, who remained in the R.A.F. to command "43" by 1928, was recalled in 1939 to serve again. John L. Trollop, repatriated in June, 1918, after being wounded in air combat and taken prisoner, was, I feel sure, also back in the R.A.F. in the last War.

Any information would be appreciated.

5 St. Hilda Street, J. L. DIXON.
Bridlington,
East Yorks.

Koolhoven Aircraft

COULD any readers help me with data and photographs of aircraft, built in England under the supervision of Frederick Koolhoven, as I am collecting material for a book about this Dutch aircraft constructor who is in danger of being forgotten.

The aircraft in which I am specially interested are: Deperdussin F.K.2, and F.K.4 to F.K.7 included, Armstrong Whitworth F.K.3 and F.K.8 up to and including F.K.21 and B.A.T. F.K.22-F.K.28 inclusive. So far as the B.A.T. aircraft are concerned I require photographs but not data. If wished the photographs will be returned to the owners.

Also, I should like to know something more about the F.K.41, which was built under licence by Desoutter in England; I do not know the numbers in which the Mk. 1 and Mk. 2 were produced, nor the countries to which these aircraft were delivered. I should be glad to have the dimensions, weights, performance, dates, etc.

Amersfoortsestraat 2, Soesterberg, D. C. TOP.
Netherlands.

Restoring a Messerschmitt

I AM writing in the hope that publication of this letter, or an extract, in your excellent magazine, will help me in my search for information required for the restoration of a Messerschmitt 109G, Serial NORN 228 which we have on the station.

I would be very glad to receive any information at all as to markings, colour schemes, serial numbers, maker's handbook, technical data, servicing instructions, etc., relating to both engines and airframes of Me 109G aircraft. Any historical data relating to this aircraft would also be of use to me.

R.A.F. Wattisham, Ipswich. J. R. HAWKE,
(Flight Lieutenant).

Wroundabout

42 to 61. *Wroundabout* recently compared the old (early '30s) H.P.42 biplane's "built-in headwinds" with the rear-engined D.H. Trident's "built-in tail-winds" and almost sacrilegiously implied that the vintage airliner was not a profit-maker. So the H.P. publicity dept., slightly aghast, have extracted from their old Bulletins and Imperial Airways records this information: Four H.P.42 Hannibal Class aircraft operated I.A.'s Eastern services from 1930; four H.P.45 (basically the 42) Heracles Class operated the London-Paris services from 1931. In two years they cut capacity-ton-mile charges by half, reliability rose from 77% to 97%, the type was found by the Aeronautical Research Committee to be "the most silent airliner" they'd tested, in five years the eight aircraft flew 52,000 hrs. and *they made a profit of more than £30 per working hour.*

Very properly, the H.P. publicity people regard the past as a step to today and point out that the Herald has nearly three times the 42's cruising speed, double the power and carries 50% more passengers. Jersey Airways' two 44-seat Heralds in the four months up to Oct. 1, flew 1,360 hrs. in 1,920 flights and carried 73,766 passengers. Their profitability is based on an operating cost of under 1d. per passenger-mile. And that, says Hugh Scuffham, H.P.'s P.R. manager, is less than it costs you to run your car.

*

Take Your Partners. I hear that Bristol Siddeley have had an inquiring letter about what the writer calls their "Double Mambo" engine, recalling a previous occasion when it was referred to as the "Double Tango," all very laughable to us experts who know that what these ignorant fools really mean is the Double Rumba.

*

"If these automatic take-off, course-keeping and landing devices are so damned infallible, why don't they put the flight deck at the back...?"

by Wroen

Industry Record

A workaday hangar scene at R.N.A.S. Yeovilton. The mobile test rig in the foreground has been specially designed by H.M.L. (Engineering) for testing the hydraulic systems of the Sea Vixen. An 80 b.h.p. Petter PDV8 diesel engine powers the unit.

Business for Brough

Two new orders placed with Blackburn Engines in recent weeks have been for the Cumulus air-bleed turbo-compressor from the M.o.A. and another for starter trolleys from the R.A.F. In neither case has a procurement figure been disclosed.

The Cumulus is the newest of the Blackburn range of gas turbines and made its initial test run at Brough only a few months ago. It delivers 2.38 lb. air/sec. at 56.5 p.s.i. and is intended mainly for use with constant-speed drive systems as an airborne auxiliary powerplant. It was developed from the Palouste.

The order for starter trolleys is the third to be received from the R.A.F.

Hunting forms FieldTech

A new company has been formed within the Hunting Light Engineering Group. This is FieldTech, Ltd., whose purpose will be to expand and exploit more fully the technical sales and consultant activities at present performed by the ancillary division of Field Aircraft Services at London (Heathrow) Airport.

Field's ancillary division—its operations and staff will be transferred to the new company—acts on behalf of three American companies in the United Kingdom. It is distributor for the majority of the aeronautical and scientific products of the Bendix Corporation and also for many of the items produced by the Leach Corporation. In addition, exclusive representation is held on behalf of Electronic Equipment Engineering, of Dallas. Negotiations are in progress with certain other manufacturers requiring a technical sales service in this country.

Mr. M. D. Newman has been appointed general manager of FieldTech; he was previously sales manager of the ancillary division. He is also elected to the board. The other directors are Mr. J. L. Smith, Mr. E. H. Baker, Mr. D. G. Lee and Mr. C. P. Dollimore.

Aiding Research at the R.A.E.

A transistorized data logging system capable of reading information from 100 transducers per sec. by a fast sequential scanning process is being developed by Mullard Equipment, Ltd., for the R.A.E. It will be used at Farnborough to examine the behaviour of models in the high-speed wind-tunnel.

Wind-tunnel tests frequently involve as many as 50 different transducers—strain gauges, thermocouples, etc.—and in order to ensure that significant variations of such things as strain, temperature and pressure are not missed it is essential that these are scanned as rapidly as possible.

The Mullard system performs five basic functions—scanning, amplification, digitization, coding and presentation. A number of scans are made during the course of a test run which can vary in length from a few seconds up to a minute. The information gathered from the various transducers is first amplified and digitized and then recorded on magnetic tape in a five-unit code.

After the run the results can be immediately recorded by a teleprinter or the magnetic tape used as an input medium to a computer. Built-in facilities are provided to check that the system is operating correctly.

Lighting at Luton

Further developments in the lighting system at Luton Airport have been made by the installation in a visual glide path indicator of a new type of miniature iodine filament lamp. This has been produced by the Osram Lamp division of G.E.C. and is its first application to aviation.

Ninety-six lamps, each of 200W and 6.6 amps have been installed. They are claimed to give 15% more light than those in standard airport usage and have 2½ times the life. At Luton the lamps have been adapted to the existing installation by enclosing them in a normal bulb in the conventional fitting.

Osram are also working on miniature iodine lamps of 500, 1,000 and 1,500W for all forms of floodlighting.

Radome De-Icing by Hot Air

New from Marston Excelsior, Ltd., an I.C.I. subsidiary, is a method of radome construction which incorporates a system for preventing the formation of ice on the outer surface.

Anti-icing is achieved by ducting hot air through a series of channels between the inner and outer reinforced glass-fibre skins. The channels, of triangular shape, are formed in the expanded rubber core and are lined with a thin glass-cloth laminate for additional strength.

The special pattern evolved permits channels of constant cross section—an important consideration for achieving adequate mechanical strength over the radome's entire surface.

Other means of providing a heated surface considered by Marston Excelsior before adopting the present patented type of construction were the incorporation of electrical elements or grids in the structure, and the use of a liquid heating medium. The former was discarded for reasons of electrical performance. The latter, although it had attractions from a heat-transfer aspect, has not been taken up because of the difficulty in finding a liquid both chemically inert and having a similar dielectric constant to the radome structure.

It is thought that the new type of construction could be used for the cooling of radomes which are subjected to high kinetic heating.

Aviation Calendar

Oct. 12

Lo.W.—R.Ae.S. main lecture at Lo.W. Branch, "Experience in Construction and Flying of Bell's Recent VTOL Aircraft," by J. A. O'Malley, at the Saunders-Roe Club House, East Cowes, at 18.00 hrs.

London.—Institute of Production Engineers, Section lecture, "The Hovercraft," by J. M. George, at the R.Ae.S., 4 Hamilton Place, W.1 at 19.00 hrs.

London.—Radar and Electronics Association lecture, "Space Communications—Systems and Equipment," by L. F. Matthews, at the Royal Society of Arts, John Adam Street, W.1, at 19.00 hrs.

London.—GAPAN lecture, "Stress and Human Performance," by Air Cdre. W. K. Stewart, at the Institution of Mechanical Engineers, 1 Birdcage Walk, S.W.1, at 18.45 hrs.

Oct. 16

London.—R.Ae.S. Astronautics and Guided Flight Section lecture, "Packaged Liquid Rocket Propulsion Systems," by W. N. Neap and K. G. Page, at 4 Hamilton Place, W.1, at 18.00 hrs.

Oct. 18

Manchester.—R.Ae.S. lecture, "Target Aircraft," by D. V. Moore, at Reynolds Hall, Manchester College of Science and Technology, at 19.30 hrs.

Oct. 19

London.—R.Ae.S. Fifth Lanchester Memorial lecture, "Ship Accompanying Waves to Shock Waves of Supersonic Aeroplanes," by R. Legendre, at 4 Hamilton Place, W.1, at 18.00 hrs.

Oct. 23

Paris.—International Airline Navigators Council, European Regional Meeting, at 30 Rue de Gramont.

Oct. 24

Glasgow.—R.Ae.S. Branch lecture by P. Gibb, at University of Glasgow, at 19.30 hrs.

Oct. 25

Weybridge.—R.Ae.S. Branch lecture, "The Supersonic Transport," by Dr. A. E. Russell, at the Apprentice Training School, Vickers-Armstrongs (Aircraft), at 17.45 hrs.

Oct. 26

Birmingham.—British Institution of Radio Engineers, West Midlands Section lecture, "Instruments for the First United Kingdom Scout Satellite," by Prof. J. Sayers, at Birmingham University, at 18.15 hrs.

London.—Institute of Transport, Metropolitan Graduate and Student Society lecture, "Development of New Aircraft and their Testing," by Sqn. Ldr. H. G. Hazeden, at 80 Portland Place, W.1, at 17.45 hrs.

Company Notices

NEW COMPANY

Business Air Travel, Ltd. (703,879).—Private co. Reg. Sept. 22. Cap. £100 in £1 shs. To carry on the business of air transport contractors. Directors: Ronald L. Gott, Southwood, Stone Street, Lympne, Kent; Frederick G. Norman, Crossways, Potters Corner, Ashford, Kent. Sec.: South Eastern Secretariat, Ltd. Reg. off.: Lympne Airport, Hythe, Kent.

CHANGE OF NAME

Alfred Porter (Overseas), Ltd. (637,769). Westwood Works, Peterborough.—Name changed to Peterborough and Spalding Aviation, Ltd., on Apr. 10, 1961.

INCREASES OF CAPITAL

British Executive and General Aviation, Ltd. (672,512). Cowley, Oxford.—Increased on Nov. 11, 1960, by £40,000 in 5s. ordinary shs., beyond the reg. cap. of £210,000.

Peterborough and Spalding Aviation, Ltd. (637,769). (Formerly Alfred Porter (Overseas), Ltd.) Dembleby House, Broad Street, Spalding, Lincs.—Increased on Mar. 24, 1961, by £2,000 in £1 ordinary shs., beyond the reg. cap. of £2,000.

Tradair, Ltd. (594,123). 64 Queen Street, E.C.4.—Increased on Feb. 13, 1961, by £14,000 in £1 ordinary shs., beyond the reg. cap. of £100,000.

Westpoint Aviation, Ltd. (676,760). 6-8 Sherborne Road, Newton Abbot.—Increased on Mar. 3, 1961, by £25,000 in £1 shs., beyond the reg. cap. of £100.

New Patents

APPLICATIONS ACCEPTED

882,186.—**Rolls-Royce, Ltd.**—"Joints." May 6, 1960. (May 13, 1959.)

882,424.—**Rolls-Royce, Ltd.**—"Aircraft jet propulsion apparatus." Mar. 16, 1959. (April 3, 1958.)

Printed specifications of the above will be available on Nov. 15, 1961, and the opposition period will expire on Feb. 15, 1962.

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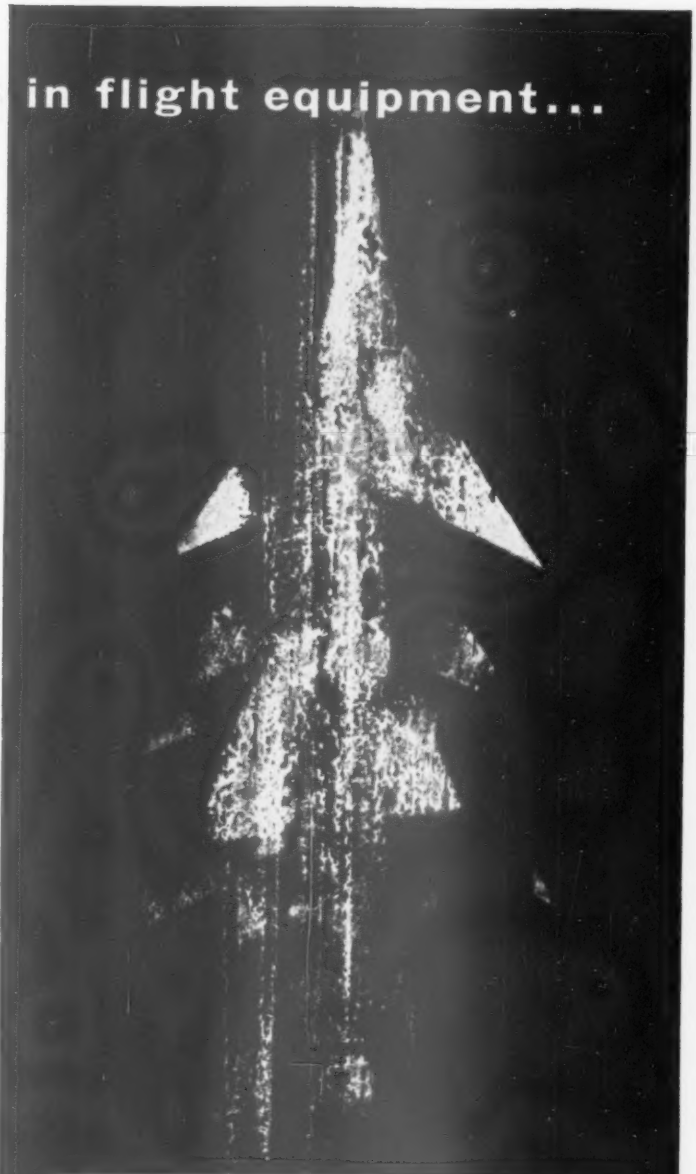

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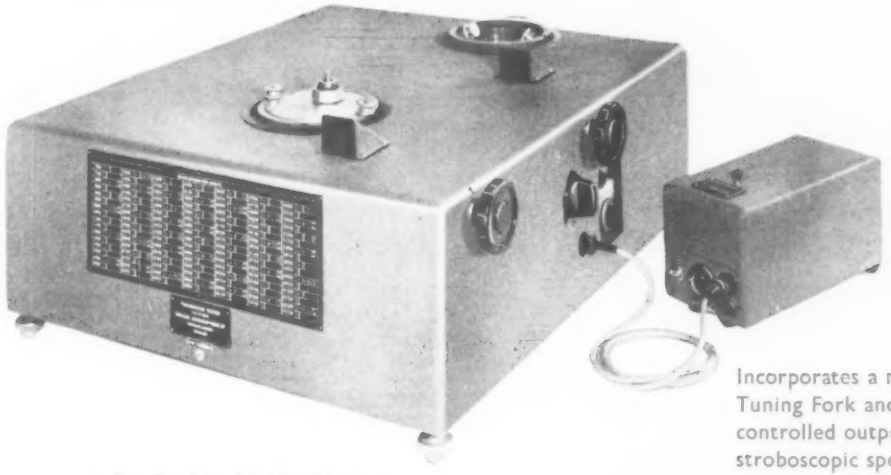

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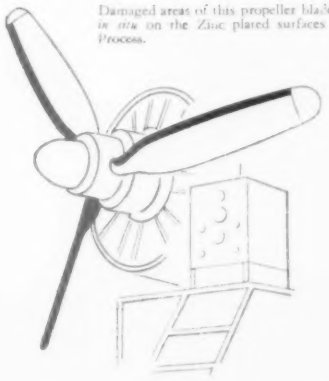

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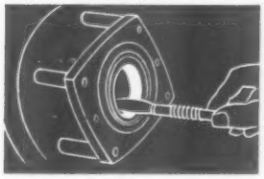

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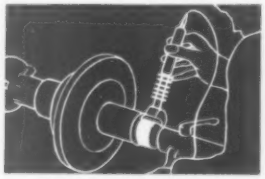

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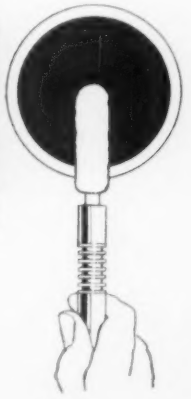

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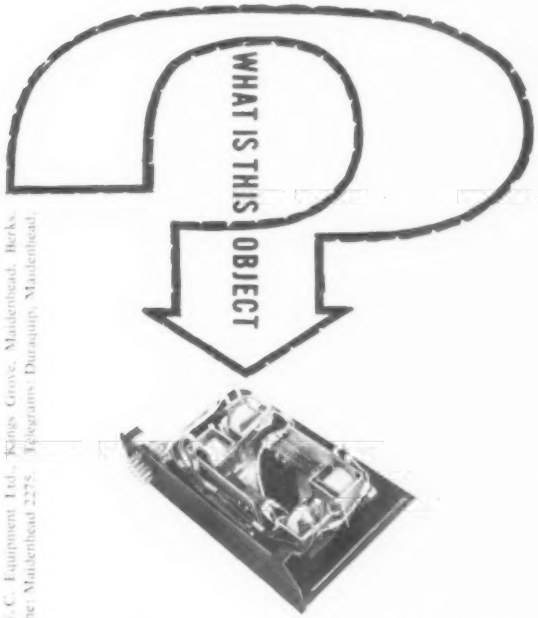

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